DEQ
Montana Department
of Environmental Quality

MAILED
AS 7-7-15

July 7, 2015

Mr. Rick Gibby
CITY OF BIG TIMBER
P.O. Box 416
Big Timber, MT 59011

RE: BIG TIMBER CLASS II LANDFILL (LIC. #308)
MARCH, 2015 POST -CLOSURE SITE INSPECTION REPORT

Dear Rick:

The Department of Environmental Quality's Solid Waste Program has reviewed the Tetra Tech March, 2015, Post-Closure Site Inspection Report for the closed Big Timber Class II landfill. The report has been placed in our files.

The report notes a reference to the post-closure care rule formerly located in Section 17.50.531 of the Administrative Rules of Montana (ARM). The post-closure care rules are now located in Chapter 50, Subchapter 14. I've enclosed a copy of those rules for your reference.

If you have questions at any time regarding the landfill's post-closure care requirements, please don't hesitate to contact me.

Sincerely,

Mary Louise Hendrickson

Mary Louise Hendrickson
Solid Waste Program
Waste & Underground Tank Management Bureau
Phone: 406-444-1808; Fax: 406-444-1374
Email: mhendrickson@mt.gov

Enclosure: ARM Subchapter 14
cc: Jeff Rice, Tetra Tech, P.O. Box 30615, Billings, MT, 59107, w/ enclosure

File: **Lic. # 308** Sweet Grass Co/Big Timber class II/ Closure-PC

Correspondence Slip

Originator: Mek

Date Requested: 6-30

Date Needed By: 7-6

REVIEW ROUTING

Name	Task	Initial/Date
Admin	Proof	AS / 7/6/15
Rica	review	RT / 7-7-15
	mailed	AS / 7-7-15
		/

✓ Mail original via:
☑ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\ Svs\ closure\ bigtimber\ ...

Special Instructions:

Mail copy of enclosures to CC's? [✓ Y] ~~N~~

Copies of enclosures for file needed? Y [✓ N]

Copy of letter for file needed? [✓ Y] N

Email copies sent? Y [✓ N]

EMAIL copy sent to Project Originator? Y [✓ N]

MAILED
8-30-13

"Healthy environment, healthy people"

Montana Department of
ENVIRONMENTAL QUALITY

Steve Bullock, Governor
Tracy Stone-Manning, Director

P. O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • Website: www.deq.mt.gov

August 29, 2013

Mr. Rick Gibby
CITY OF BIG TIMBER
P.O. Box 416
Big Timber, MT 59011

RE: POST -CLOSURE SITE INSPECTION – FOLLOW-UP
BIG TIMBER CLASS II LANDFILL (LIC. #308)

Dear Rick:

This letter is provided as follow-up to the Solid Waste Program's (SWP) response to your submittal of Tetra Tech's March, 2013, post-closure inspection and our subsequent site visit. The March, 2013, post-closure site inspection report noted the need for some basic post-closure repairs at the facility. Because the SWP requires the post-closure maintenance of the areas affected by solid waste operations, the SWP's response requested the submittal of a post-closure repair work plan for review. Prior to the submittal of a work plan, you requested the SWP conduct a site inspection to evaluate the need for additional repairs at the site.

To that end, on July 25, 2013, John Collins and I inspected the site for vegetative success. The final cover over the closed waste disposal unit and the vegetation established on the former burn pit area looked good. No further action is required.

If you have any questions regarding this site inspection, please don't hesitate to contact me directly.

Sincerely,

Mary Louise Hendrickson

Mary Louise Hendrickson
Solid Waste Program
Waste & Underground Tank Management Bureau
Phone: 406-444-1808; Fax: 406-444-1374
Email: mhendrickson@mt.gov

cc: Jeff Rice, Tetra Tech, P.O. Box 30615, Billings, MT, 59107

File: **Lic. # 308** Sweet Grass Co/Big Timber class II/ Closure-PC

4.75
2,25
7,

3,75
5,25
9

Correspondence Slip

Date Requested: 8-28

Originator: mlk

Date Needed By: 8-29

REVIEW ROUTING

Name	Task	Initial/Date
Admin Janet	Proof	Jh / 8-28
Rick	review	RT / 8-29-2013
		/
		/

Mail original via:
● Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at

Proof Path: G:\WUT\________________________

Special Instructions:

~~Mail copy of enclosures to CC/s?~~ Y N

~~Copies of enclosures for file needed?~~ Y N

Copy of letter for file needed? [✓ Y] N

~~Email copies sent?~~ Y N

EMAIL copy sent to Project Originator? Y [✓ N]

Tim Stepp 7/15/2013

#445

Stepp, Tim

From: Stepp, Tim
Sent: Monday, July 15, 2013 10:28 AM
To: 'City of Big Timber'
Cc: O'Hern, Kathleen
Subject: RE: Howie Road Landfill

Hi Gayle,

Please apologize to Rick. Our inspectors are very busy, but they are informed of the situation. As far as I know, Kathy O'Hern (406.444.9879) will soon be heading that way when it fits into her mid-summer circuit and inspection timing. She will contact Rick before she visits the facility.

Please thank Rick again for the telephone discussion informing DEQ of his concerns regarding post closure maintenance. As I said then and in the letter, we are not expecting revegetation of undisturbed areas or outcrops, only areas affected by solid waste operations. A site inspection should help to identify those areas, especially with regard to the final cover and burn pit as noted.

Thanks for your patience.

Tim

Please log and file. Closure. Thx

TIM STEPP
Environmental Engineer - Solid Waste Program
Waste & Underground Tank Management Bureau
Permitting & Compliance Division

Montana Department of
ENVIRONMENTAL QUALITY

Lee Metcalf Building
1520 East Sixth Ave
P.O. Box 200901
Helena, MT 59620-0901

Phone 406-444-4725
Fax 406-444-1374
email: tstepp@mt.gov

From: City of Big Timber [mailto:citybtmt@ttc-cmc.net]
Sent: Thursday, July 11, 2013 4:09 PM
To: Stepp, Tim
Subject: Howie Road Landfill

On June 5th the Big Timber Public Works Director called you, relative to your letter of May 30, 2013 requesting a Final Cover Repair Plan. He has concerns about your department
expecting any kind of cover to grow on a shale ridge, especially with the winds we have
in this area, and no water source available. He asked that you send someone to Big Timber
to inspect the site with him and see where his concerns lie. He said that you told him you

would have someone from your department visit the landfill with him. That was 36 days ago, and we have not seen or heard from anyone yet. We have a lot of projects in the works and we would like to get this taken care of before it gets pushed to the back burner. Please let me know what date and time your representative will be available in Big Timber to inspect the site and offer suggestions on how to comply with your request for a Final Cover Plan.

Sincerely,

Gayle McPherson
Clerk/Treasurer
Big Timber, MT 59011
406-932-5611
citybtmt@ttc-cmc.net

Montana Department of
ENVIRONMENTAL QUALITY

Steve Bullock, Governor
Tracy Stone-Manning, Director

P. O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • Website: www.deq.mt.gov

MAILED
5-30-13 JL

May 30, 2013

Mr. Rick Gibby
P.O. Box 416
Big Timber, MT 59011

RE: INFORMATION REQUEST—POST-CLOSURE REPAIRS
Big Timber Class II Landfill (Lic. #308)

Dear Mr. Gibby:

Thank you for the 2013 *"Post-Closure Site Inspection"* report that was received by the Solid Waste Program (SWP). Your engineer has noted the extended need for some basic post-closure repairs at the facility, as required by the Post Closure Plan (PCP).

Please submit a brief Final Cover Repair Plan for SWP approval including: (i) cover maintenance along the east flank of the waste cell; and (ii) placement of topsoil and revegetation over the abandoned burn pit. You may reference the existing PCP for topsoil and revegetation specifications. We suggest that some form of mulch may be necessary to encourage stability and promote growth in these areas.

We appreciate your cooperation. Please contact me for assistance at the Permitting and Compliance Division: Telephone (406) 444-4725 or email tstepp@mt.gov.

Sincerely,

Tim Stepp
Solid Waste Program
Waste & Underground Tank Management Bureau

Cc: Jeff Rice, Tetra Tech, P.O. Box 30615, Billings, MT, 59107

File: **Lic. # 308** Sweet Grass Co/Big Timber class II/ Closure-PC

Correspondence Slip **Project ID:** # 308

Requested: 5/15/13
Originator: T. Stepp
Needed By:
Org(s)/Mail Code:

REVIEW ROUTING

Name	Task	Initial/Date
Admin J.H.	Proof	Jh / 5-15
Mary H.		mh / 5-29
Rick T.		RT / 5-30-2013
		/

Mail original via:
☒ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\

Special Instructions:

Please copy & file per footer.

Copy TS. Thx

Mail copy of enclosures to CC's? Y N

Copies of enclosures for file needed? Y N

Copy of letter for file needed? [✓ Y] N

MAILED
2-11-08 jh

Montana Department of
ENVIRONMENTAL QUALITY

Brian Schweitzer, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov

February 8, 2008

Ms. Gail McPherson
City of Big Timber Public Works
P.O. Box 416
Big Timber, MT 59011

RE: APPROVAL—UPDATED POST-CLOSURE CARE PLAN
City of Big Timber Class II Landfill (Lic. #308)

Dear Ms. McPherson:

The Department has completed its review of the updated Post-Closure Care Plan submitted to support the post-closure FA cost estimates for the City of Big Timber Class II landfill.

The Closure/Post-Closure Plan update is approved as submitted.

The required financial assurance update will be addressed separately.

If you have any questions or comments, please contact me for assistance at the Permitting and Compliance Division: Voice (406) 444-4725 or email *tstepp@mt.gov*.

Sincerely,

Tim Stepp
Solid Waste Program
Waste & Underground Tank Management Bureau

File: **Lic. # 308** /Sweet Grass Co/class II/Big Timber /Closure-Post Closure
Path: G:\WUT\SWS\closure\bigTimber\BigTimberCPCPlanApprov0208.doc

Correspondence Slip

Project ID: #413

Requested: 2/8/08

Needed By:

Originator: T. Stepp

Org(s)/Mail Code:

REVIEW ROUTING

Name	Task	Initial/Date
Admin Janet H.	Proof	JH / 2-8-08
Mary H.		MH / 2-8
Rick T.		RT /
		/

Mail original via: ☒ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\

Mail copy of enclosures to CC's? Y N

Copies of enclosures for file needed? Y N

Copy of letter for file needed? [✓ Y] N

Special Instructions:

Please copy & file per Fooke.

Thx.

MAILED
5-1-07 jh

Montana Department of
ENVIRONMENTAL QUALITY
Brian Schweitzer, Governor
P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov

April 30, 2007

Ms. Diana Taylor
P.O. Box 416
Big Timber, MT 59011

RE: NOTICE OF DEFICIENCY–POST CLOSURE CARE & FINANCIAL ASSURANCE
Big Timber Class II Landfill (Lic. #308)

Dear Ms. Taylor:

Post closure care at the Big Timber Class II landfill must meet the requirements of ARM 17.50.531. In particular, the Department conditionally approved (on 9/6/01) groundwater monitoring at the facility once every two years in the absence of detected contaminants, but the last monitoring event was on April 27, 2001. Your request for a one-time extension of the monitoring event is approved as long as it is accomplished no later than September 30, 2007. Given the gap in monitoring data, at least three more sampling events are required (2007, 2009, & 2011). You may contact Mary Hendrickson (phone 406.444.1808) for landfill groundwater and methane monitoring assistance.

Please submit for approval an updated 30-yr Post Closure Plan that includes sections requiring groundwater monitoring every two years until released by approval, quarterly methane monitoring, and annual inspection by a registered engineer (report and cost estimate updates due April 1 each year). Also, please submit for approval documents verifying the current annual adjustment of the itemized 30-yr post-closure cost estimates and the Certificate of Deposit (CD) funds to cover all anticipated post-closure costs according to ARM 17.50.540. The CD mechanism requires a standby trust to potentially accept funds from the CD as necessary (upon DEQ request). Please execute the standby trust agreement mailed to the City (on compact disk) with the Department's annual FA letter in 2006. The Department can also email a copy of the trust form to you.

We appreciate your prompt response. For assistance, please contact me at the Permitting and Compliance Division: Voice (406) 444-4725 or email *tstepp@mt.gov*.

Sincerely,

Tim Stepp
Solid Waste Program
Waste & Underground Tank Management Bureau

Cc: Mary Hendrickson, DEQ Solid Waste Program
File: **Lic. # 308** Sweet Grass Co/Big Timber/Class II/Post Closure … and… /FA
Path: G:\WUT\SWS\FA\bigTimber\BTimberPC-FANOD0307.doc

Enforcement Division • Permitting & Compliance Division • Planning, Prevention & Assistance Division • Remediation Division

Correspondence Slip

Project ID: #308

Requested: 3/26/07

Needed By:

Originator: T. Stapp

Org(s)/Mail Code:

REVIEW ROUTING

Name	**Task**	**Initial/Date**
Janet H.		Jh / 3-29
Pat C.	wt	/
Rick T.	acting	Sd / 5/1
Darrell S.		Cas / 4/9

Mail original via:
☒ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\___________________________________

Mail copy of enclosures to CC's? Y N

Copies of enclosures for file needed? Y N

Copy of letter for file needed? [✓ Y] N

Special Instructions:

Please copy & file per folder.

Thx.

Montana Department of
ENVIRONMENTAL QUALITY

Judy H. Martz, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.state.mt.us

February 22, 2001

Mr. Ron Thomas
P.O. Box 416
Big Timber, MT 59011

RE: FINAL CLOSURE APPROVAL
BIG TIMBER CLASS II LANDFILL (Lic. #308)

Dear Mr. Thomas:

Thank you for responding to our request for completion of the final closure requirements at this landfill. The deed notation filed with this office on February 12, 2001, meets the requirements of ARM § 17.50.530(1)(i), thus, the Department approves final closure of the facility.

Please submit a post-closure care (PCC) plan that meets the requirements of ARM § 17.50.531(1)(c). The PCC plan can be developed from the appropriate monitoring and maintenance sections of the O&M Plan, but must ensure the integrity of the landfill cap, leachate collection and removal system, and groundwater monitoring system and provide for their continued operation and monitoring over 30 years. You may also need to provide an adjustment of your post-closure financial assurance (FA) to reflect the appropriate costs involved in post-closure care as provided in the plan [ARM § 17.50.540(3)(a)(i) – (v)]. The PCC plan must be accompanied by an itemized justification for the current level of FA. The PCC Plan, FA justification, and FA adjustments may be provided with the FA annual report that is due on April 1, 2001.

We appreciate your cooperation. If you have any questions or comments, please contact me at the Permitting and Compliance Division, Community Services Bureau, Waste Management Section: Telephone (406) 444-4725, email *tstepp@state.mt.us* or FAX (406) 444-1374.

Sincerely,

Tim Stepp
Solid Waste Licensing Program

Cc: Rod Fink, Sweet Grass Co. Sanitarian
File: Lic. # 308 Sweet Grass Co/Big Timber class II/Post Closure and… /Financial Assurance
Path: G:\CSB\S w s\closure\btimber_finclosr0201.doc

INITIALS TS DATE 2/22/01

SW OUTGOING CORRESPONDENCE 2001

☐ **NEW APPLICATION/LICENSE** **Initial / Date**

Mike D.
Janet H.
HAC
Rick T.
Jon D./ Other

☐ **HEALTH OFFICER CARD** **Initial / Date**

Mike D.
Karen
HAC

☐ **INSPECTIONS** **Initial / Date**

Pat C.
Janet H.
Karen
Rick T.

☐ **CLOSURES** **Initial / Date**

Mike D.
Janet H.
Karen
HAC
Rick T./ Other

☐ **FEES** **Initial / Date**

Mike D.
Janet H.
HAC

☐ **COMPLAINTS** **Initial / Date**

Pat C.
Janet H.
Karen

☐ **GROUND WATER** **Initial / Date**

Janet H.
Pat C
Rick T.

☐ **GENERAL CORRESPONDENCE** **Initial / Date**

Pat C. / Mike D.
Janet H.
Rick T.
Jon D./ Other

☒ **MISCELLANEOUS** PCC/FA **Initial / Date**

Mike D.
Janet H. Jth 02-22-0
Rick T. 2-22-01

FILE
Path

FAX TO TIM STEPP, MT DEQ, WASTE MANAGEMENT SECTION (1/23/01) (FAX 444-1374)

SUBJECT: CITY OF BIG TIMBER LANDFILL CLOSURE

Tim, attached is the deed restriction I referenced in my voice mail message. As I commented, the City Attorney and I put this together but would appreciate your comment before filing it.

As you stated in your letter of November 13, 2000, we will provide you with a filed copy once this is completed.

Thanks.

Erl Tufte
Morrison-Maierle, Inc.

Tele. 656-6000

County Sweet Grass Big Timber
Facility & # #308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Landfarm
Liner
Methane
O & M
Run - On
Other:

RECEIVED

JAN 24 2001

MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

1/24/01 Called Earl for changes

NOTICE

NOW COMES the CITY OF BIG TIMBER, a MONTANA MUNICIPAL CORPORATION, P.O. Box 416, Big Timber, MT 59011, and gives notice under the provisions of ARM17.50.530 (1) (h) (ii) regarding the following described real property owned by said CITY:

↑(i)

> A tract of land located in the northeast quarter of Section 8, Township 1 North, Range 15 East P.M.M., Sweet Grass County, Montana, being more particularly described as follows:
>
> The south 990 feet of the west 500 feet of Tract A, Certificate of Survey No. 117632, Sweet Grass County, Montana, as filed 4-9-90 in the office of the Clerk and Recorder of Sweet Grass County, Montana.

↓(i)

This notice is given to conform to the above ARM17.50.530 (1) (h) (ii) by giving notice to the public and particularly to any potential purchaser of the above described real property that said real property was used as a landfill by the City of Big Timber, that the property has been closed as a landfill, and that its use is restricted under the provisions of ARM17.50.531 (1) (c) (iii), as follows:

> "Post-closure use of the property must not disturb the integrity of the final cover, liner, or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in these rules. The department may approve any other disturbance if the owner or operator demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste. will not increase the potential threat to human health or the environment."

This notice should be used in reference to the Warranty Deed to the City of Big Timber, dated February 14, 1991, and recorded in Book 67, Page 752, in the office of the Clerk and Recorder of Sweet Grass County, Montana.

Dated this the _____ day of ________________, 2001.

CITY OF BIG TIMBER

BY:______________________________
Gary Smart, Mayor

ATTEST

BY:______________________________
Lois Stevens, Clerk

CLOSED

County Sweet Grass

Facility & # Big Timber

Closure
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections

Landfarm
Liner
Methane
O & M
Run-on

Other:
post-closure

TETRA TECH

March 22, 2013

RECEIVED

MAR 26 2013

DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

Mr. Rick Gibby
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: **Post-Closure Site Inspection**
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 1159731053.100

Dear Mr. Gibby:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech on March 12, 2013 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site.

The general appearance of the closed landfill and vegetative cover throughout the site is good. Some minor issues were again observed; however, areas previously noted as being sparse appear to be slowly re-vegetating. Small bare spots were observed east and south of the former waste cell and burn pit (Figure 1). An approximate 500 square feet area bare spot was observed just northeast of BT-2 (Figure 1). Additionally, a larger area approximately 1,000 to 2,000 square feet was also noted further to the north and east of the former waste cell. The west side of the former burn pit currently has little vegetation established. Minor erosion is visible in this area although no rills or gullies are present which would indicate significant erosion. These areas were all observed during the previous inspections.

Tetra Tech
P.O. Box 30615, Billings, MT 59107
618 South 25th Street, Billings, MT 59101
Tel 406.248.9161 Fax 406.248.9282 www.tetratech.com

With the exception of an approximate 150 foot section located near the southwest corner of the property which is worn and loose, the perimeter fence is in place and in good condition. No trash or other materials were observed within the fenced perimeter.

Post-Closure Site Recommendations

Tetra Tech recommends the areas of bare soil over the waste cell be re-seeded and protected from wind erosion according to the Big Timber Landfill Post-Closure Plan to prevent erosion. The areas of sparse vegetation and bare spots over the former burn pit should also have a minimum six inch layer of topsoil re-spread over these sites and be re-seeded with an appropriate seed mix. The damaged fence located near the southwest corner of the property should be repaired.

For your convenience, we have forwarded a copy of this report to the MDEQ. If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech

Travis Goracke, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

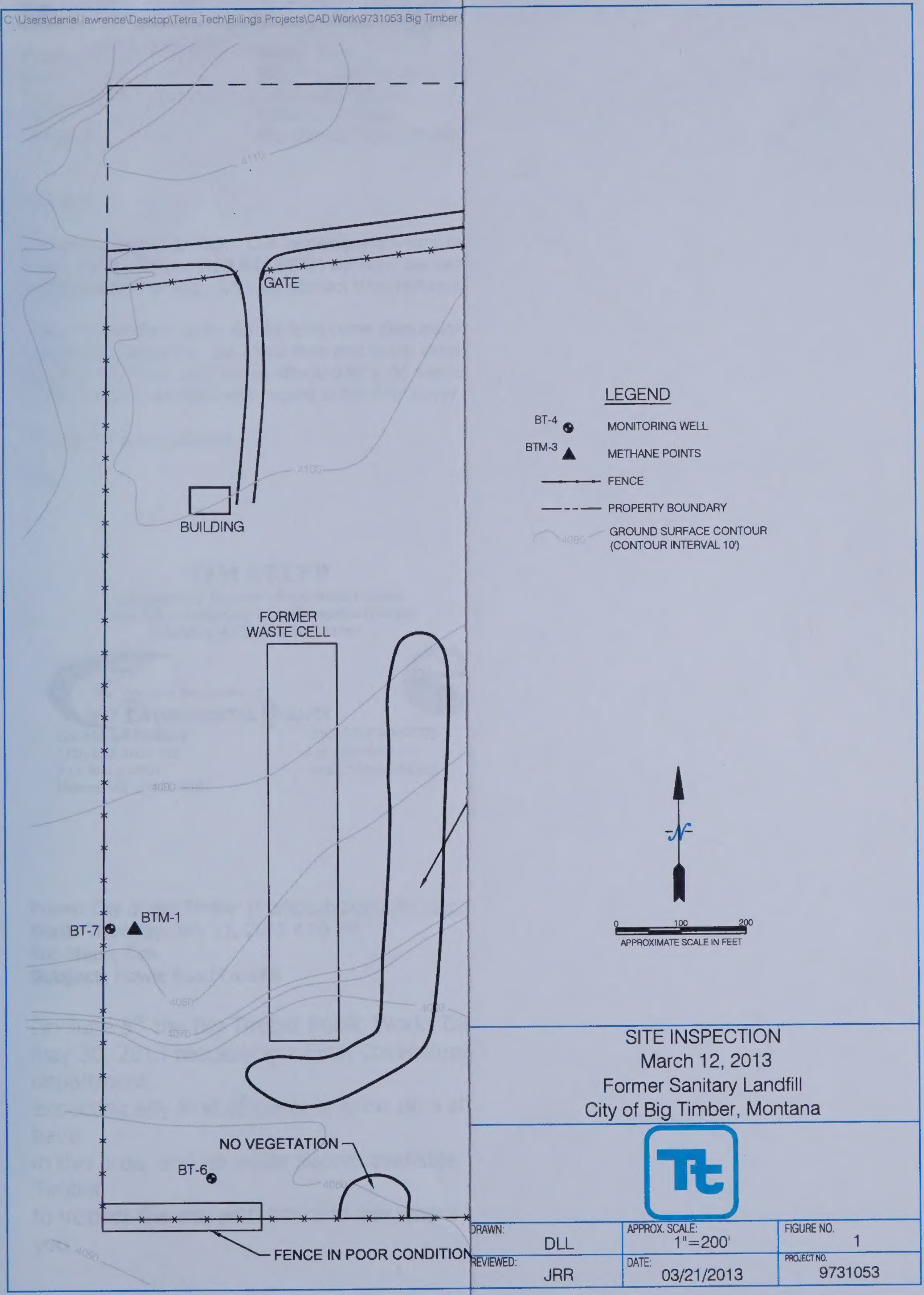
TG/JRR/ba N:\TYPING\ENV-FAC\9731053\BT Post Closure 2013\BT Post-Closure Site Inspec 2013.doc

Enclosures:

Figure 1 – Site Inspection Base Map

(In two copies)

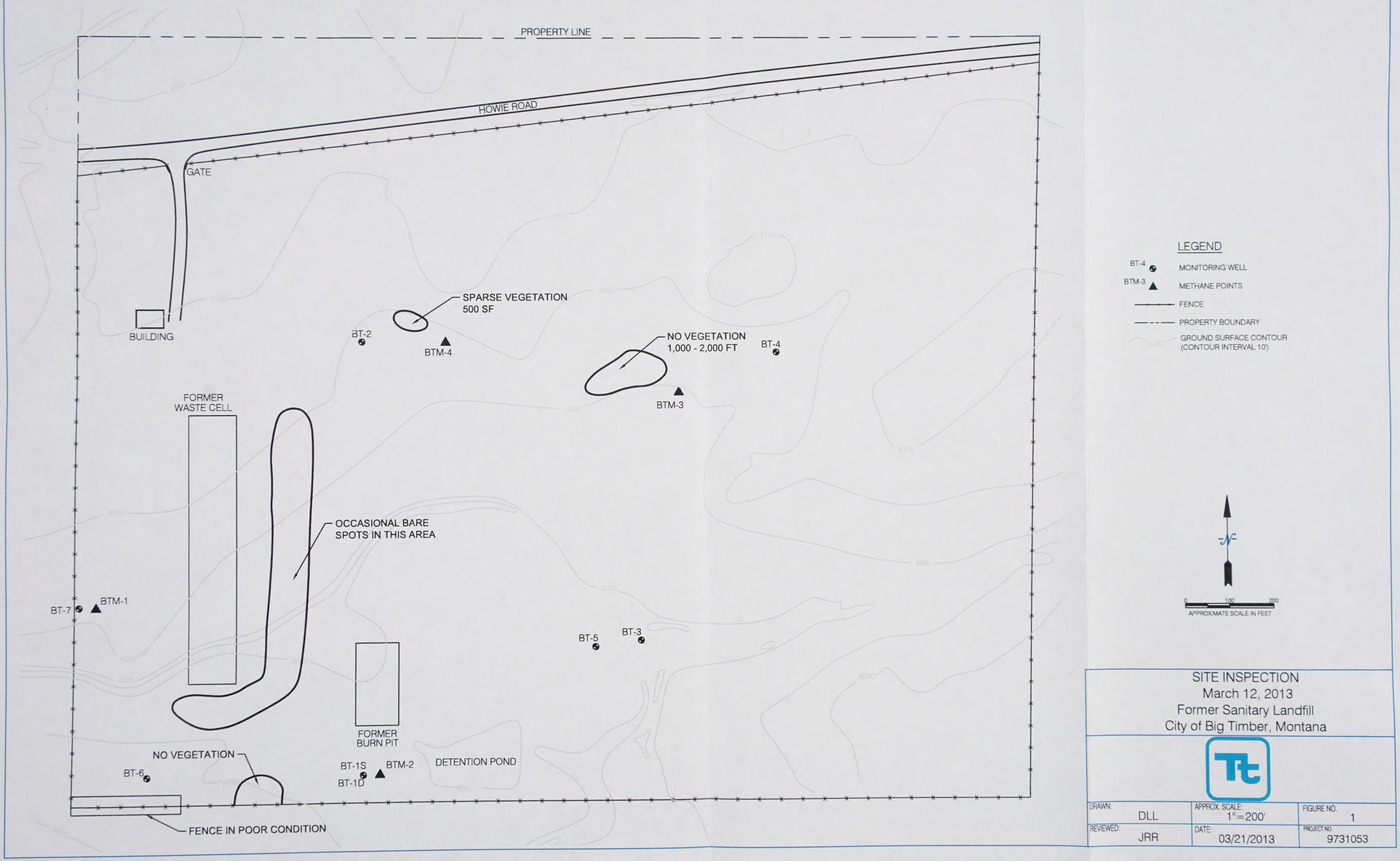
cc: Gayle McPhearson
Martin Van Oort, MDEQ, Helena, MT, delivered via email mvanoort@mt.gov


C:\Users\daniel.lawrence\Desktop\Tetra Tech\Billings Projects\CAD Work\9731053 Big Timber
4110
GATE
4100
BUILDING
FORMER WASTE CELL
4090
4080
4070
BT-7
BTM-1
NO VEGETATION
BT-6
4060
FENCE IN POOR CONDITION
4050
LEGEND
BT-4 ● MONITORING WELL
BTM-3 ▲ METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURFACE CONTOUR (CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE INSPECTION
March 12, 2013
Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: DLL	APPROX. SCALE: 1"=200'	FIGURE NO. 1
REVIEWED: JRR	DATE: 03/21/2013	PROJECT NO. 9731053

C:\Users\daniel.lawrence\Desktop\Tetra Tech\Billings Projects\CAD Work\9731053 Big Timber Landfill\9731053-March 21 2013.dwg


PROPERTY LINE
HOWIE ROAD
GATE
BUILDING
SPARSE VEGETATION
500 SF
BT-2
BTM-4
NO VEGETATION
1,000 - 2,000 FT
BT-4
BTM-3
FORMER
WASTE CELL
OCCASIONAL BARE
SPOTS IN THIS AREA
BT-7
BTM-1
BT-5
BT-3
FORMER
BURN PIT
NO VEGETATION
BT-6
BT-1S
BTM-2
BT-1D
DETENTION POND
FENCE IN POOR CONDITION
LEGEND
BT-4 ● MONITORING WELL
BTM-3 ▲ METHANE POINTS
FENCE
PROPERTY BOUNDARY
GROUND SURFACE CONTOUR
(CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE INSPECTION
March 12, 2013
Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: DLL	APPROX. SCALE: 1"=200'	FIGURE NO. 1
REVIEWED: JRR	DATE: 03/21/2013	PROJECT NO. 9731053

7/445

Stepp 7/15/2013

Stepp, Tim

From: Stepp, Tim
Sent: Monday, July 15, 2013 10:28 AM
To: 'City of Big Timber'
Cc: O'Hern, Kathleen
Subject: RE: Howie Road Landfill

Please log
and file.
Closure. Thx

Hi Gayle,

Please apologize to Rick. Our inspectors are very busy, but they are informed of the situation. As far as I know, Kathy O'Hern (406.444.9879) will soon be heading that way when it fits into her mid-summer circuit and inspection timing. She will contact Rick before she visits the facility.

Please thank Rick again for the telephone discussion informing DEQ of his concerns regarding post closure maintenance. As I said then and in the letter, we are not expecting revegetation of undisturbed areas or outcrops, only areas affected by solid waste operations. A site inspection should help to identify those areas, especially with regard to the final cover and burn pit as noted.

Thanks for your patience.

Tim

TIM STEPP
Environmental Engineer - Solid Waste Program
Waste & Underground Tank Management Bureau
Permitting & Compliance Division

Montana Department of
ENVIRONMENTAL QUALITY

Lee Metcalf Building
1520 East Sixth Ave
P.O. Box 200901
Helena, MT 59620-0901

Phone 406-444-4725
Fax 406-444-1374
email: tstepp@mt.gov

From: City of Big Timber [mailto:citybtmt@ttc-cmc.net]
Sent: Thursday, July 11, 2013 4:09 PM
To: Stepp, Tim
Subject: Howie Road Landfill

On June 5th the Big Timber Public Works Director called you, relative to your letter of May 30, 2013 requesting a Final Cover Repair Plan. He has concerns about your department
expecting any kind of cover to grow on a shale ridge, especially with the winds we have
in this area, and no water source available. He asked that you send someone to Big Timber
to inspect the site with him and see where his concerns lie. He said that you told him you

would have someone from your department visit the landfill with him. That was 36 days ago, and we have not seen or heard from anyone yet. We have a lot of projects in the works and we would like to get this taken care of before it gets pushed to the back burner. Please let me know what date and time your representative will be available in Big Timber to inspect the site and offer suggestions on how to comply with your request for a Final Cover Plan.

Sincerely,

Gayle McPherson
Clerk/Treasurer
Big Timber, MT 59011
406-932-5611
citybtmt@ttc-cmc.net

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Dept. of Envirn. Quality
Waste & Underground
Tank Management Bureau

Report of

Draft Amended Post-Closure Care Plan Sanitary Landfill Big Timber, MT

August 2007

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Waste & Underground
Tank Management Bureau

Transmittal Letter

To:	Tim Stepp	**From:**	Jeff Rice
Company:	Mt Dept of Environmental Quaility	**Date:**	August 31, 2007
Re:	For your review and comments	**Project #:**	9731053.200
CC:			

Please Find Enclosed:

1 *copy of* Draft amended Post-Closure Care Plan for City of Big Timber Sanitary Landfill

Comments:

Ship Via:

☐ FedEx: ☐ Priority ☐ Standard ☐ 2-day Economy ☐ Ground
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Draft Amended Post-Closure Care Plan

Big Timber Sanitary Landfill

Prepared for:

City of Big Timber

PO Box 416
Big Timber, MT 59011

Prepared by:

Tetra Tech

618 South 25th Street
Billings, MT 59101
(406) 248-9161
Fax (406) 248-9282
Tetra Tech Project No. 1159731053.200

August 24, 2007

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1.0 INTRODUCTION

This post-closure care plan for the Big Timber Sanitary Landfill near Big Timber, Montana satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531. This plan was prepared by Tetra Tech for the City of Big Timber. A closure plan was prepared and submitted to Montana Department of Environmental Quality (MDEQ) in April 1998.

1.1 Facility Description

The Big Timber Sanitary Landfill is located in the north half of Section 8, Township 1 North, Range 15 East, Sweetgrass County, Montana (Figure 1). The permitted size of the landfill is 80 acres and the design life was 60 years. Approximately 10 acres in the southwest portion of the site have been disturbed.

The landfill is located on gently sloping rangeland, approximately one-half mile north of the Yellowstone River flood plain. The hydrogeologic setting at this site consists of water bearing sandstone and mudstone interbedded with non-water bearing shale of the Cretaceous Hell Creek Formation. Approximately ten feet of silty clay overlies the Hell Creek bedrock sediments in the northeastern two-thirds of the site. The Hell Creek sediments consist of primarily mudstone (shale) with stringers of sandstone and siltstone. Groundwater is encountered primarily in the sandstone and flows in a southwesterly direction under a gradient that varies from approximately 2.5 percent in the central portion of the landfill property to approximately 6.7 percent in the southwestern portion downgradient of the former waste cell and burn pit (Maxim Technologies, Inc., 1998).

1.2 Facility History

The Big Timber Sanitary landfill received approximately 2,000 tons of waste per year placed in one cell in the southwestern portion of the site from 1992 until 1997. The cell measured approximately 10 feet wide by 60 feet long by 20 feet deep. The landfill stopped accepting waste and closed in April 1997 (Maxim Technologies, Inc., 1998).

The landfill currently has a network of seven groundwater monitor wells (Figure 2). Four monitor wells were installed in 1989, two wells were installed in 1990, and one well was installed in 1995. Groundwater monitoring was first conducted in 1994 and continued to present. Four methane monitor wells were installed in 1994 (Figure 2) and methane monitoring was first conducted in 1994. A landfill closure plan was written in 1998 (Maxim Technologies, Inc., 1998).

1.3 Landfill Closure

The landfill was closed according to the 1998 Closure Plan (Maxim Technologies, Inc., 1998). Specifically, sandy clay loam with a permeability of 9×10^{-6} centimeters per second was placed and compacted to a depth of 18 inches over the landfill waste cell. On-site stockpiled seedbed material (topsoil) was placed over the cover material to an approximate depth of six inches. Seeding was done in May 1999 using a mixture of native seeds at the following rate:

- Western wheatgrass (1.5 pounds per acre)
- Streambank wheatgrass (1.25 pounds per acre)
- Bluebunch wheatgrass (1.75 pounds per acre); and
- Slender wheatgrass (1.5 pounds per acre).

In January 2001, a deed restriction was filed with the Sweetgrass County (Montana) Clerk and Recorder listing the city property in the north half of Section 8, Township 1 North, Range 15 East, Sweetgrass County, Montana as having been used as a municipal Class II landfill.

2.0 FACILITY CONTACT

The facility contact is:

Mr. Rick Gibby
Director of Public Works
City of Big Timber
P.O. Box 416
Big Timber, Montana 59011
406-932-5646

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3.0 DESCRIPTION OF MONITORING AND MAINTENANCE ACTIVITIES

3.1 Landfill Cover Maintenance

Periodic inspections of the landfill cover have been conducted by the City of Big Timber since the Landfill was closed in April 1997. The 30 year post closure period required by ARM 17.50 will require continued post closure monitoring and potential maintenance through 2027. Future annual inspection shall be conducted by the City Public Works Director or designate in the spring of each year through 2027. The inspector shall document the integrity and effectiveness of the cover soils, including subsidence, erosion, condition of the vegetative cover (i.e., vegetation density, sod cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence, and overall general appearance of the landfill site. This documentation shall be kept on file at the City offices for review.

If the vegetative cover is thin or large bare spots occur, the affected cover areas will be repaired and reseeded according to the Big Timber Landfill closure plan (Maxim Technologies, Inc., 1998). Erosion of the cover will also be repaired according to the Big Timber Landfill closure plan. Documentation of any corrective measures shall also be kept on file. Oversight of these inspections will be the responsibility of the Public Works Director. Final closure of the Class II landfill unit must be certified by an independent registered professional engineer. All documentation must be placed in the operating record.

3.2 Leachate Collection System Maintenance

Leachate was not generated during the life span of the operating landfill and a leachate collection system was not designed or built. Therefore, future leachate collection maintenance will not be conducted.

3.3 Groundwater Monitoring

Groundwater monitoring has been conducted at the Big Timber Sanitary Landfill from 1994 to 2001 and resumed in May 2007. The groundwater monitoring network consists of seven monitor wells, four upgradient (BT-2, BT-3, BT-4, and BT-5) and three downgradient of the waste cell and burn pit (BT-1S, BT-6, and BT-7; Figure 2). The monitor well logs are included as Appendix A.

Groundwater monitoring has consisted of measuring water levels in select wells (BT-1S, BT-2, BT-6 and BT-7; Figure 2) and preparing a groundwater potentiometric surface map. Groundwater samples were analyzed for the parameters listed in ARM 17.50.708(a)(iv)(I). Volatile organic constituents have never been detected in any landfill sample. Statistical analysis was conducted on the inorganic groundwater sampling results comparing upgradient results to downgradient results. Per MDEQ correspondence (MDEQ, 2007), three additional groundwater monitoring events will be conducted during 2007, 2009 and 2011.

3.4 Methane Gas Monitoring

Landfill gas was monitored for the percentage of lower explosive limit (LEL) six times between 1994 and 1996, then again during April 2001 and August 2007. A summary of the methane monitoring results is shown on Table 1. The percent LEL was used to monitor for potential methane gas in the four gas monitor wells (BTM-1 through BTM-4; Figure 2), and the landfill building.

Concentrations of explosive gases ranged from zero to a maximum of two percent of the LEL during the first monitoring event conducted during 1994. These levels are all well below the lower explosive limit of 100 percent. The most recent explosive gas measurements were conducted during May 2007 and explosive concentrations were below the instrument detection limit. Since the landfill is not located near any human-occupied structures and gases in the explosive range have not been measured, future methane gas monitoring will be conducted during groundwater monitoring events during 2009 and 2011.

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TABLE 1
METHANE GAS MONITORING RESULTS
BIG TIMBER SANITARY LANDFILL

Monitor Location	October 1994	January 1995	April 1995	July 1995	October 1995	January 1996	April 2001	August 2007
BTM-1	2	<1	<1	<1	<1	<1	<1	<1
BTM-2	<1	1	<1	<1	<1	<1	<1	<1
BTM-3	1	1	1	<1	<1	<1	<1	NA
BTM-4	<1	1	<1	<1	<1	<1	<1	<1
Site Building	NA	1	<1	1	<1	<1	<1	NA

LEL = lower explosive limit
NA = not analyzed
< = less than

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4.0 POST-CLOSURE CARE PERIOD

The post-closure period shall be thirty years beginning following closure in 1997. Annual inspections of the landfill will be conducted by the City of Big Timber during this thirty year period. Two additional groundwater monitoring events will be conducted in the spring of 2009 and 2011. Two additional methane monitoring events will be conducted concurrently with the groundwater monitoring events. The closed portion of the landfill property (i.e., the former landfill waste cell) will not be used for any activity during the post-closure care period. The former operations building may continue to be utilized by the City of Big Timber for activities not related to landfill operations.

5.0 POST-CLOSURE CARE COST ESTIMATE

Post-closure care costs for the entire post-closure care period have been estimated in current dollars based on the activities presented in this post-closure care plan. The estimated costs are shown on Table 2.

TABLE 2
POST-CLOSURE CARE PLAN COST ESTIMATE
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA
August 2007

TASK	QUANTITY	RATE	COST
Landfill Inspection/Certification			
Project Engineer, per hour	6	165.00	990.00
Project Scientist, per hour	6	85.00	510.00
Vehicle, per mile	180	0.50	90.00
Inspection Subtotal			$600.00
Total Final Inspection Cost			**1,590.00**
Groundwater Monitoring Event (includes Inspection and Methane Monitoring & Assumes All Wells Sampled)			
Sampling			
Project Manager, per hour	1	115.00	115.00
Project Scientist, per hour	6	85.00	510.00
Senior Technician, per hour	6	59.00	354.00
Landfill volatile organics, per sample[1]	8	225.00	1,800.00
Landfill volatile inorganics, per sample (includes duplicate)	7	250.00	1,750.00
Sampling disposable materials, per sample	7	15.00	105.00
Disposable metals filter, per sample	7	25.00	175.00
Peristaltic pump rental, per day	1	50.00	50.00
Groundwater sampling instrument rental, per day	1	125.00	125.00
Vehicle, per mile	180	0.50	90.00

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TABLE 2 (continued)
POST-CLOSURE CARE PLAN COST ESTIMATE
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA
August 2007

TASK	QUANTITY	RATE	COST
Groundwater Monitoring Event (includes Inspection and Methane Monitoring & Assumes All Wells Sampled) (continued)			
Reporting			
Data management and report preparation, per hour	20	85.00	1,700.00
Senior review, per hour	2	115.00	230.00
Drafting, per hour	2	50.00	100.00
Clerical, per hour	2	45.00	90.00
Groundwater Monitoring (Per event)			**$7,194.00**
Total Groundwater Monitoring (Three Events)[3]			**$21,582.00**
Methane Monitoring Event			
Project Scientist, per hour	2	85.00	170.00
Groundwater sampling instrument rental, per day	1	55.00	55.00
Reporting			
Data management and report preparation, per hour	2	85.00	170.00
Senior review, per hour	1	115.00	115.00
Drafting, per hour	0.5	50.00	25.00
Clerical, per hour	0.5	45.00	22.50
Methane Monitoring (Per event) [4]			**$557.50**
Total Methane Monitoring (Three Events)			**$1,672.50**
Total Post-Closure Care Cost[5]			**$24,844.50**

[1] includes duplicate and lab blank. Costs are based on sampling all site wells. Sampling and Analysis Plan recommends only four wells to be sampled.

[2] Includes duplicate only.

[3] Three events to be conducted 2007, 2009 and 2011.

[4] Cost assumes methane monitoring will only be conducted concurrently with groundwater monitoring. Three events to be conducted 2007, 2009 and 2011.

[5] All costs based on 2007 prices.

6.0 REFERENCES CITED

Maxim Technologies, Inc., 1998. Closure Plan, Big Timber Landfill, Big Timber, Montana. Unpublished document submitted to the City of Big Timber, Montana. April.

Maxim Technologies, Inc., 2001. April 2001 Groundwater Monitoring Results, Big Timber Sanitary Landfill, Big Timber, Montana. Unpublished document prepared for City of Big Timber, Montana. August.

Montana Department of Environmental Quality, 2007. Letter correspondence for Tim Stepp to the City of Big Timber,

Tetra Tech, 2007, May 2007 Groundwater Monitoring Results, Big Timber Sanitary Landfill, Big Timber, Montana. Unpublished document prepared for City of Big Timber, Montana. August.

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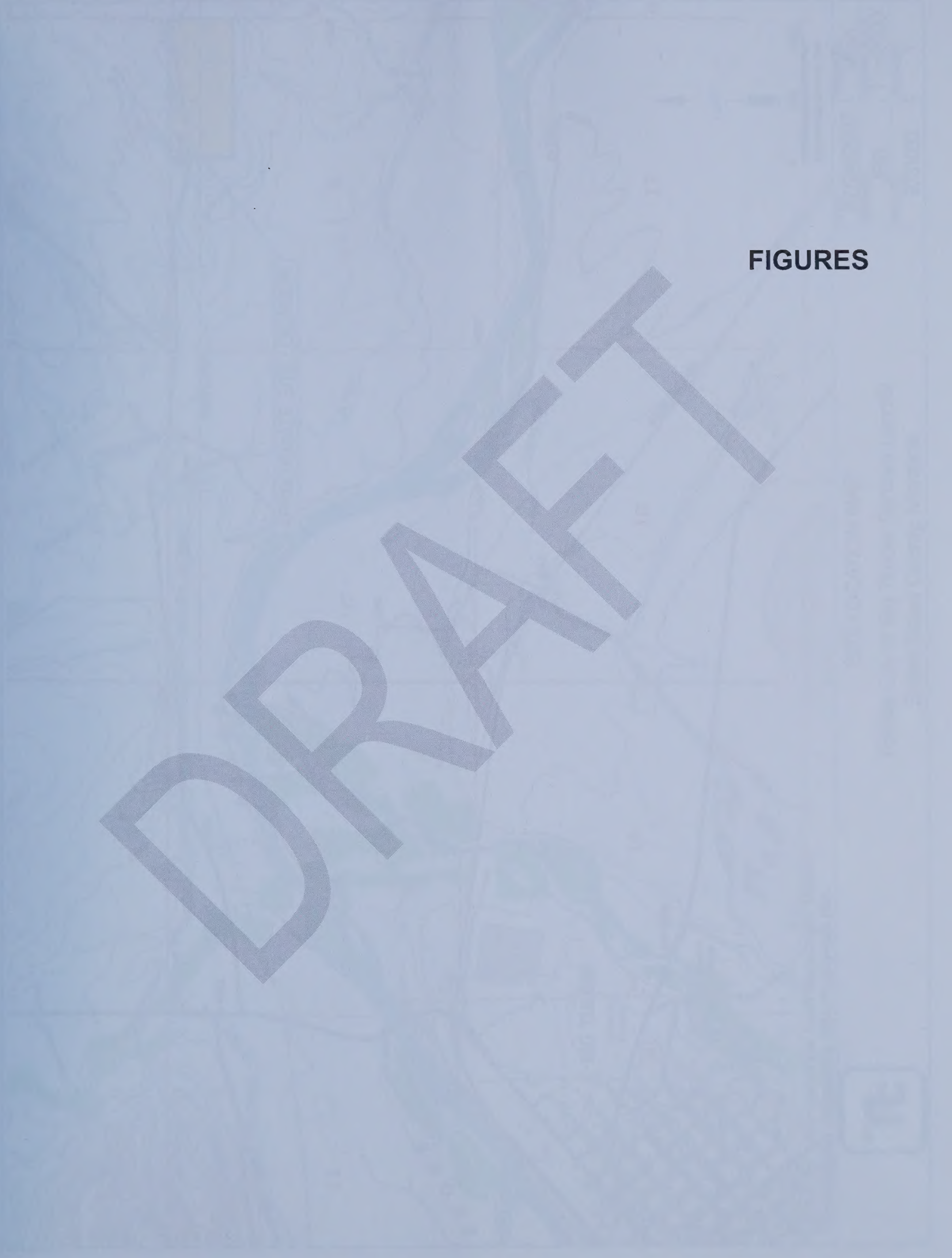

FIGURES

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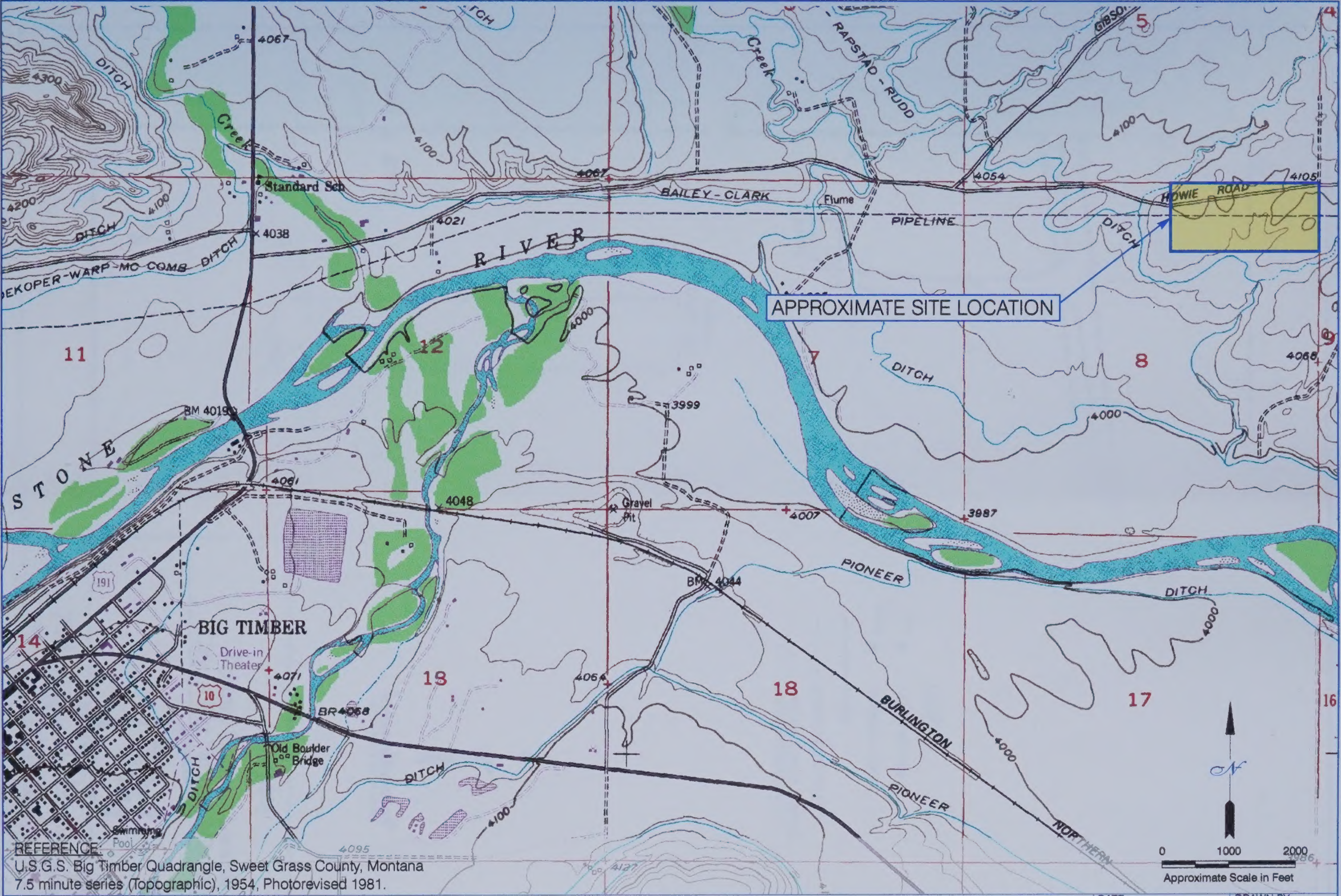
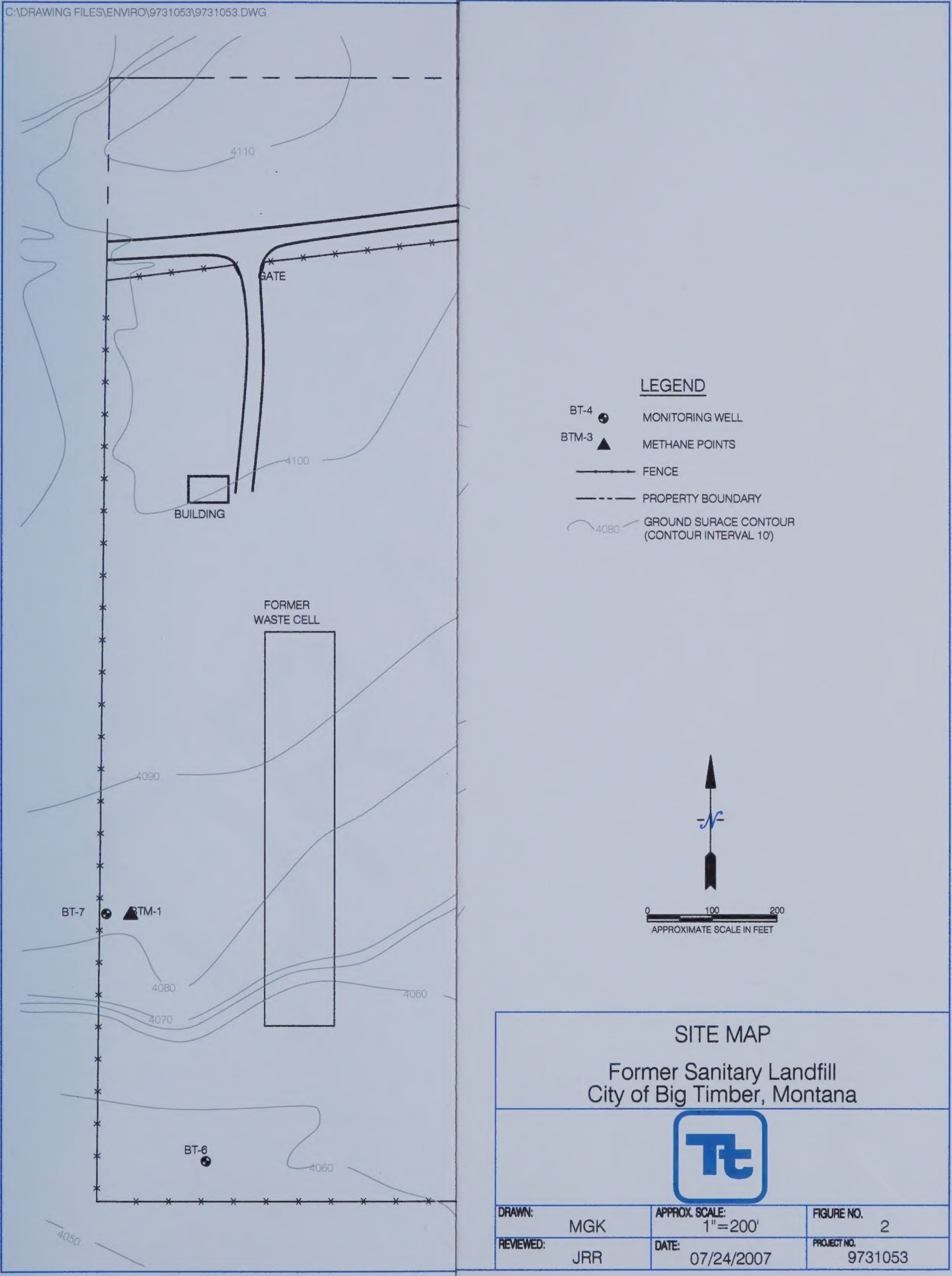

APPROXIMATE SITE LOCATION
HOWIE ROAD
BAILEY-CLARK
PIPELINE
DITCH
Flume
RAPSTAD-RUDD
Creek
GIBSON
RIVER
STONE
Standard Sch
EKOPER-WARP-MC COMB DITCH
BIG TIMBER
Drive-in Theater
Old Boulder Bridge
Swimming Pool
Gravel Pit
PIONEER DITCH
PIONEER
BURLINGTON NORTHERN
BM 4019
BM 4044
BR 4068
4067
4038
4021
4054
4105
4100
4200
4300
4000
3999
4061
4048
4007
3987
4068
4071
4064
4095
4127
5
7
8
9
11
12
13
14
16
17
18
191
10
N
0
1000
2000
Approximate Scale in Feet

REFERENCE:
U.S.G.S. Big Timber Quadrangle, Sweet Grass County, Montana
7.5 minute series (Topographic), 1954, Photorevised 1981.

SITE LOCATION MAP
Former City of Big Timber Sanitary Landfill
Sweet Grass County, Montana

DATE: 07/24/2007	DRAWN BY: MGK
REVIEWED: JRR	APPROX. SCALE: 1"=2000'
PROJ. NO.: 9731053	FIGURE NO.: 1

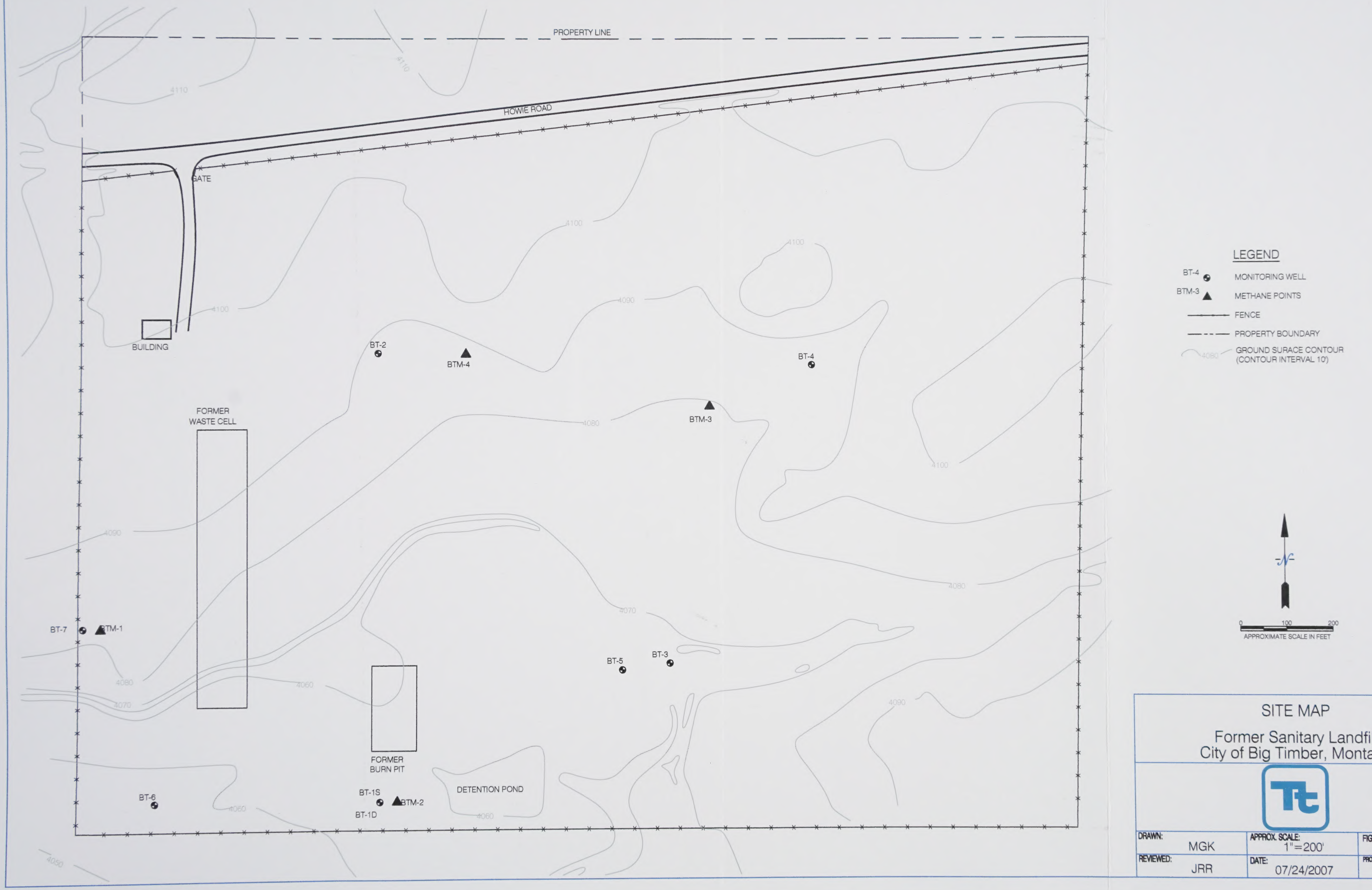

C:\DRAWING FILES\ENVIRO\9731053\9731053.DWG
4110
GATE
4100
BUILDING
FORMER WASTE CELL
4090
BT-7
BTM-1
4080
4070
4060
BT-6
4060
4050
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURACE CONTOUR (CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE MAP

Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: MGK	**APPROX. SCALE:** 1"=200'	**FIGURE NO.** 2
REVIEWED: JRR	**DATE:** 07/24/2007	**PROJECT NO.** 9731053

C:\DRAWING FILES\ENVIRO\9731053\9731053.DWG


PROPERTY LINE
HOWIE ROAD
GATE
BUILDING
FORMER
WASTE CELL
BT-2
BTM-4
BT-4
BTM-3
BT-7
BTM-1
BT-5
BT-3
BT-6
FORMER
BURN PIT
BT-1S
BT-1D
BTM-2
DETENTION POND
4110
4100
4090
4080
4070
4060
4050
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURACE CONTOUR
(CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE MAP

Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: MGK	APPROX. SCALE: 1"=200'	FIGURE NO. 2
REVIEWED: JRR	DATE: 07/24/2007	PROJECT NO. 9731053

APPENDIX A

Monitor Well Logs

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Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-1 shallow & deep

Legal Location: T 1N R 15E Sec 8 Tract ABDD Descriptive Location: 400′ west of draw, downgradient of proposed L.F.

Recorded By: D. Hazen Hole Started: Time: 1045 Date: 05/23/89 Hole Completed: Time: 1545 Date: 05/23/89 Driller: Rock Creek Drilling, Bill Kupfner

Drill Method: Rotary Drilling Fluids Used: Air Pilot Hole Diameter: 8" to 9′ Drilled Hole Diameter: 6"

Total Depth Drilled: 80′ Total Depth Reamed: ______ Total Depth Cased Below G.S.: ______ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 35.5-25.5 68.5-58.5 Target Aquifer: Fox Hills Formation Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	x	
Well Test Pumped?		x
Water Samples Taken?		x
Material Samples Taken?	x	
E-Logs?		x

Method Perforated or Screened

______ No casing in hole
______ Open bottom
______ Slotted with Mill′s Knife
______ Slotted with a torch
______ Screened by pulling casing
______ Field saw cut
x Mechanical slots 0.030 (size)
______ Other (specify) ______

Static Fluid Level Below Measuring Point: 18.40 18.75 19.27′ Date/Time Measured: 06/01/89 @ 0850 05/24/89 @ 0839 05/23/89 @ 1734

Measuring Point Description/Elevation: Top of steel well protector, +2.82 ft. MP Height Above (+/-) or Below G.S.: +2.82′

Well Annulus Completion Description: Dual Completion: 80′-72′, cuttings; 72-71.5′, Wyo-Ben bentonite; 71.5′-56.6′, 10-20 Colorado Silica Sand; 56.6′-38′, Wyo-Ben Bentonite (medium); 38′-22′, 10-20 Colorado Silica Sand; 22′-11′, Wyo-Ben Bentonite (medium)

Well Development Description: Bailed 15 gallons from both the shallow and deep wells; performed bailer Recovery Test on each well.

Remarks: 7" steel surface casing installed to 9 ft. below ground surface. Volclay bentonite pellets placed from 9′ to 8′ BGS outside of 7" steel and 8′ to 1′ backfilled with clay/shale cuttings, concrete surface seal installed around steel surface casing. Ground surface at BT-1 assumed elevation of 0.0 ft.

DRILLING AND LITHOLOGIC LOG

BT-1

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1′	Topsoil/organic material
1′	27′	Gray clay/shale, friable, minor silt and sand, dry minor organics
27′	28′	Silty sandstone, minor water <0.5 gpm, dark red. No recovery with split spoon sampler.
28′	38′	Sandstone and shale interbedded - dark red - making approximately 2 gallons per minute
38′	60′	Gray shale, dry - sealing off water in upper zone (27 to 38′)
60′	66′	Red sandstone with some shale - making 5-6 gpm
66′	74′	Gray shale
74′	80′	Shale with some red sand interbeds, still making 5-6 gpm

TD = 80′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-2

Legal Location: T 1N R 15E Sec 8 Tract ABAD Descriptive Location: 100′ west of TP-10, 100′ NE of TP-1, upgradient

Recorded By: D. Hazen Hole Started: Time: 1600 Date: 05/23/89 Hole Completed: Time: 1710 Date: 05/23/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air/Water Pilot Hole Diameter: 8" to 9′ Drilled Hole Diameter: 6" to 47′, 4-7/8" 47′-90′

Total Depth Drilled: 90′ Total Depth Reamed: --- Total Depth Cased Below G.S.: 42.4′ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 32.4-42.4 Target Aquifer: Sandstone lenses Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		x
Well Test Pumped?		x
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		x

Method Perforated or Screened	
	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
x	Mechanical slots 0.010 (size)
	Other (specify)

Static Fluid Level Below Measuring Point:	Date/Time Measured:
23.64	09/07/89 @ 1130
23.38	06/01/89 @ 1330
29.20	05/24/89 @ 0830
46.62	05/23/89 @ 1713

Measuring Point Description/Elevation: Top of steel well protector, 125.6 ft. MP Height Above (+/-) or Below G.S.: +2.7′

Well Annulus Completion Description: 90 - 47′, cuttings; 47′ - 43′, Bentonite chips; 43′ - 30′, 10-20 Colorado Silica Sand; 30′ - 16′, Volplug Bentonite chips

Well Development Description: 9/8/89 - bailed approximately 25 gallons

Remarks: 7" steel surface casing installed to 9′ BGS with bentonite seal. Measuring Point Elevation determined by level survey; Datum (0.0′) is ground surface at well BT-1, well deepened from 47.2′ to 90′ on 9/7/89

SC = 580, T = 11 C, pH = 9.1

DRILLING AND LITHOLOGIC LOG

BT-2

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	15′	Overburden, gray silt with clay, ocassional boulder, slightly moist
15′	21′	Brown to light brown shale, friable, dry
21′	25′	Brown shale, friable, dry
25′	40′	Light gray to brown mudstone, dry
40′	42′	Light purple to gray, clay/shale, slightly moist
42′	47.2	Light gray to brown mudstone, slightly moist
47.2′	55′	Gray sandy shale, very hard drilling, several soft intervals
55′	65′	Gray clay shale, friable, easier drilling, let well recover at 59 ft. for 10 minutes, slight amount of water, no noticeable increase from 47′
65′	70′	Shale/mudstone, dark gray, hard drilling
70′	79′	Clay/shale, soft., slight amount of water, no noticeable increase from 47′, hard drilling 76′ - 77′ and 78′ - 78.5′
79′	90′	Clay shale/mudstone, gray and gray brown, let sit at 90′ - very slight amount of water, no noticeable increase from 47′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-3

Legal Location: T 1N R 15E Sec 8 Tract AACD Descriptive Location: 230' SE of Test Pit 12, 30' N of draw at S edge of site

Recorded By: D. Hazen Hole Started: Time: 1440 Date: 09/07/89 Hole Completed: Time: 1600 Date: 09/07/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air/Water Pilot Hole Diameter: 8" Reamed Hole Diameter: 4 3/4"

Total Depth Drilled: 21' Total Depth Reamed: ______ Total Depth Cased Below G.S.: 20.7' Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 7.7 - 17.7 Target Aquifer: Alluvial Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		
Well Test Pumped?		
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		

	Method Perforated or Screened
	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
x	Mechanical slots 0.010 (size)
	Other (specify)

Static Fluid Level Below Measuring Point: 14.67' 14.81' Date/Time Measured: 09/08/89 @ 1145 - after overnight stablization 09/07/89 @ 1618

Measuring Point Description/Elevation: Top of steel surface casing MP Height Above (+/-) or Below G.S.: +1.5'

Well Annulus Completion Description: 20.7 - 7.0', 10-20 Colorado Silica Sand; 7.0 - 5.5, volplug bentonite chips.

Well Development Description: Bailed approximately 20 gallons - would not go dry

Remarks: 11.5' 7" steel surface casing installed to 9.5', sealed with Volplug bentonite 1/4" pplets

SC = 1574, T = 11 C

PH = 7.9 @ 11 C

DRILLING AND LITHOLOGIC LOG

BT-3

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1′	Topsoil
1′	3′	Sand with silt, brown
3′	12′	Clay with minor fine sand and silt, slightly moist, dark brown, firm
12′	14′	Sand/gravel - possible sandstone lense, wet
14′	17′	Clay with silt and firm sand, brown
17′	20′	Clay, minor silt, slightly moist
		Making approximately 2 gpm at 20′
		TD - 20′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-4

Legal Location: T 1N R 15E Sec 8 Tract AACA Descriptive Location: Northwest of landfill site in small draw

Recorded By: D. Hazen Hole Started: Time: 1600 Date: 09/07/89 Hole Completed: Time: 1715 Date: 06/07/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air Pilot Hole Diameter: 8" Reamed Hole Diameter: 4-3/4"

Total Depth Drilled: 50′ Total Depth Reamed: ______ Total Depth Cased Below G.S.: 43.2′ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 38.2 - 28.2 Target Aquifer: Mudstone Beds Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		
Well Test Pumped?		
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		

Method Perforated or Screened
____ No casing in hole
____ Open bottom
____ Slotted with Mill's Knife
____ Slotted with a torch
____ Screened by pulling casing
____ Field saw cut
x Mechanical slots 0.010 (size)
____ Other (specify) ______

Static Fluid Level Below Measuring Point: 16.62′ 32.40′ Date/Time Measured: 09/08/89 @ 900 09/07/89 @ 1921

Measuring Point Description/Elevation: Top of steel surface casing MP Height Above (+/-) or Below G.S.: +2.0′

Well Annulus Completion Description: 50′ - 41′, caved material; 41′ - 23′, 10-20 Colorado Silica Sand; 23′ - 8′ Volplug medium chips Bentonite

Well Development Description: Bailed approximately 20 gallons - let recover
SWL = 38.6′ after bailing dry
29.5 1056 approximately 5 minutes later

Remarks: 11.5′ surface casing installed with bentonite chip seal.
pH = 8.1 , T = 10.5 C
SC = 1307

DRILLING AND LITHOLOGIC LOG

BT-4

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	2′	Silty sand, brown
2′	10′	Clay with minor silt, dark gray brown
10′	10.5′	Hard sandstone
10.5′	20′	Clay/shale - dry - slightly moist, gray brown
20′	34′	Clay - very hard; dry and dusty, light gray, hard
34′	39′	Slightly moist, clay with mudstone clasts.
39′	41′	Clay, brown, very moist No standing water @ 40′ - wet cuttings
41′	50′	Clay, light gray, hard, dry and dusty
		(Water on drill steel - 16′ off bottom)
		TD - 50′

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO.: 89-3020.L

PROJECT: Big Timber Landfill **STATE:** MT **COUNTY:** Sweetgrass **WELL NO.:** BT-5

LEGAL LOCATION: T 1N R 15E S 8 **TRACT** AACD

DESCRIPTIVE LOCATION: 170' West, 20' North of BT-3

DATE STARTED: 7/19/90 **DATE COMPLETED:** 7/19/90 **DRILLING COMPANY/ DRILLER:** ESD/Ed Hillman **LOGGED BY:** D. Hazen

DRILLING METHOD: Rotary **BOREHOLE DIAMETER (in):** 5 7/8" **DRILL FLUIDS USED:** Air

TOTAL DEPTH DRILLED (ft): 31' **TOTAL DEPTH CASED (ft):** 29' **INTERVAL PERFORATED OR SCREENED (ft):** from: 24.0 to: 29.0 **DIAMETER AND TYPE OF CASING:** 2" PVC, Sch 40

METHOD OF PERFORATION:
___ Open Hole
___ Open Bottom
___ Saw Slotted
X Mechanical Slots 0.020 (size)
___ OTHER (specify) ___

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
WELL DEVELOPED	X	
WELL PUMPED		X
WATER SAMPLES COLLECTED		X
MATERIAL SAMPLES COLLECTED	X	

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: Length 15 ft Diam. 6"
LOCK NO.: 2265

SURFACE SEAL: Type: Concrete from: 0 to: 0.5
BACKFILL: Material: Bentonite from: 7 ft to: 21 ft
FILTER PACK: Type: 10-20 Silica from: 21 ft to: 30 ft

STATIC WATER LEVEL: 18.45 **MEASURING POINT DATE:** 7/20/90 **DESCRIPTION/ ELEVATION:** Top of steel well protector, N side at mark, 4069.25 ft **MEASURING POINT RELATIVE TO GROUND SURFACE (+/-):** +2.7'

REMARKS: 12.3' of 6" Steel casing installed in boring below ground surface. Finished boring at 1100 hours. Cuttings/caved material from 30 to 31 ft.

INTERVAL (FT) below ground surface	LITHOLOGIC DESCRIPTION	REMARKS
0-8'	Silt, Clay and Sand, light brown	dry
8-10'	Sandstone lense, gray, fine grained	hard drilling
10-15'	Silty Clay, gray to reddish brown, minor sand	slightly moist
15-16'	Sandstone, light gray brown, medium grained	dry
16-19.5'	Silty clay, reddish brown, minor sand	slightly moist - let sit at 17.5' for 5 minutes, dry
19.5-20'	Sandstone lense	dry
20-26	Silty clay, gray	slightly moist to 25', very moist at 25'
26-27'	Sandstone, dark gray, medium to fine grained	Making 1/2 - 1/4 gpm water
27-31'	Silty clay, gray	slightly moist

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO.: 89-3020.L

PROJECT: Big Timber Landfill STATE: MT COUNTY: Sweetgrass WELL NO.: BT-6

LEGAL LOCATION: T 1N R 15E S 8 TRACT ABDD

DESCRIPTIVE LOCATION: 500 feet west of BT-1

DATE STARTED: 7/19/90 DATE COMPLETED: 7/19/90 DRILLING COMPANY/ DRILLER: ESD/Ed Hillman LOGGED BY: D. Hazen

DRILLING METHOD: Rotary BOREHOLE DIAMETER (In): 5 7/8 DRILL FLUIDS USED: Air

TOTAL DEPTH DRILLED (ft): 37' TOTAL DEPTH CASED (ft): 25' INTERVAL PERFORATED OR SCREENED (ft): from: 25.0 to: 30.0 DIAMETER AND TYPE OF CASING: 2" PVC, Sch. 40

METHOD OF PERFORATION:
☐ Open Hole
☐ Open Bottom
☐ Saw Slotted
☒ Mechanical Slots 0.020 (size)
☐ OTHER (specify)

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
WELL DEVELOPED	X	
WELL PUMPED		X
WATER SAMPLES COLLECTED		X
MATERIAL SAMPLES COLLECTED	X	

ANNULAR COMPLETION CHARACTERISTICS
WELL PROTECTOR: Length 10 ft Diam. 6"
LOCK NO.: 2265
SURFACE SEAL: Type: Concrete from: 0 to: 0.5 ft
BACKFILL: Material: Bentonite from: 6' to: 23'
FILTER PACK: Type: 10-20 silica sand from: 23 ft to: 33 ft

STATIC WATER LEVEL: 22.85 MEASURING POINT DATE: 7/20/90 DESCRIPTION/ ELEVATION: Top of Steel Well Protector, N side at mark, 4057.57 MEASURING POINT RELATIVE TO GROUND SURFACE (+/-): +2.3'

REMARKS: 7.7' of 6" steel in ground

INTERVAL (FT) below ground surface	LITHOLOGIC DESCRIPTION	REMARKS
0-2'	Top soil, silty sand, loose, brown	dry
2-6'	Silty clay, brown to gray	dry
6-7'	Clay/Shale layer	hard drilling
7-12'	Silty clay, dark gray, minor sand	
12-22'	Sandy mudstone, light gray	dry, relatively hard drilling
22-26'	Mudstone with sand, dark gray	dry, moist at 26'
26-33'	Sandy Mudstone, dark gray, likely mudstone with sand interbedded	making water at 26-27', and at 29-29.5'
33-37'	Silty clay, reddish brown	slightly moist, slight oil sheen on mud return

m No. 603 (R 2-89)

WELL LOG REPORT

File No. ________

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER WELL BT-7

Name CITY OF BIG TIMBER

2. CURRENT MAILING ADDRESS

P.O. BOX 415
BIG TIMBER, MT. 59011

3. WELL LOCATION

NW ¼ SW ¼ NE ¼ Section 8
Township 1N N/S Range 15 E E/W County SWT GRASS
Govn't Lot ______, or Lot ______, Block ______
Subdivision Name ______
Tract Number ______

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☒ Specify TOR MONITOR

5. TYPE OF WORK:

New well	☒	Method: Dug	☐	Bored	☐
Deepened	☐	Cable	☐	Driven	☐
Reconditioned	☐	Rotary	☒	Jetted	☐

6. DIMENSIONS: Diameter of Hole

Dia. 7 7/8 in. from 0 ft. to 5 ft.
Dia. 5 7/8 in. from 5 ft. to 47 ft.
Dia. ____ in. from ____ ft. to ____ ft.

7. CONSTRUCTION DETAILS:

Casing; Steel Dia. 6 from +3 ft. to 7'10" ft.
Threaded ☐ Welded ☒ Dia. ____ from ____ ft. to ____ ft.
Type A-53 Wall Thickness .250
Casing; Plastic Dia. 2 from 2'3" ft. to 47 ft.
Weight S.40IFJ Dia. ____ from ____ ft. to ____ ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used ______
Size of perforations ____ in. by ____ in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name MONOFLEX
Type ______ Model No. ______

f) Duration of test: Pumping time ____ hrs.
g) Recovery time ____ hrs.
h) Recovery water level ____ ft. at ____ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? ____ Yes x No
If yes, how? ______

12. WELL LOG

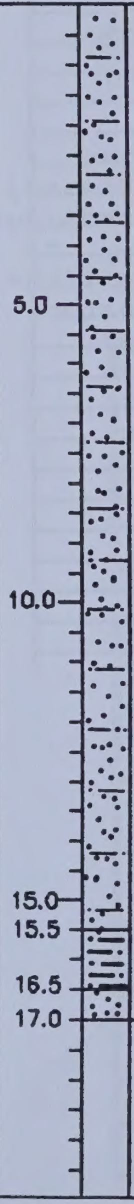
Depth (ft.) From	To	Formation
0	1	top soil/S.S. cobbles
1	5	S.S. W/silts, lite brwn
5	9	S.S. W/SILT
9	11	FINE SAND, soft
11	13	fine gray/brwn S.S.
13	27	gray sand/mudstone/hard
27	31	purple/black mudstone/sand/
31	33	hard/fine grain mudstone/pur
33	35	soft/fine grain " "
35	37	soft purple/black sand/fine
37	42	hard purple/black mudstone
42	43	gray S.S. soft water
43	47	purple clay/mudstone

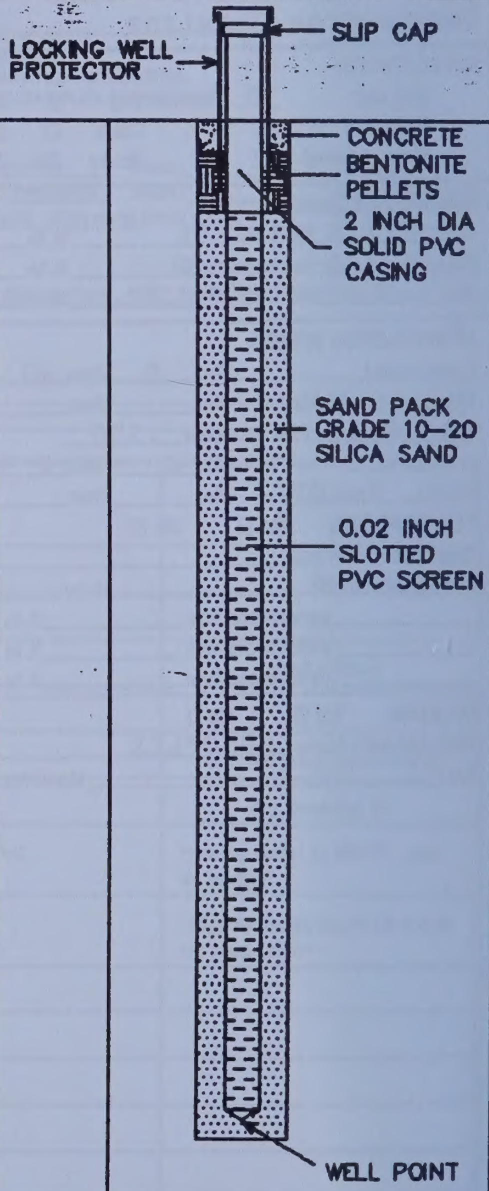
Huntingdon
Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL	WELL NO: BTM-1
	SHEET NO: 1 OF 1
JOB NO: 94-657	LOCATION: 340' N, 50' W OF WELL BT-6
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER	ELEVATION: TOP OF HOLE NOT MEASURED GROUNDWATER
DRILLED BY: W. NIEMI	
LOGGED BY: D. TYLER	DATE: HOLE STARTED 10/10/94
REMARKS: NONE	COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
0.0–15.5		SANDSTONE; very fine grained, silty, light tan, dry, occasional clayey zones				
15.5–16.5		SILTSTONE; argillaceous, well cemented, brown				
16.5–17.0		SANDSTONE				
		Bottom of Hole = 17.0 feet				


5.0
10.0
15.0
15.5
16.5
17.0


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

Huntingdon
Engineering & Environmental, INC.

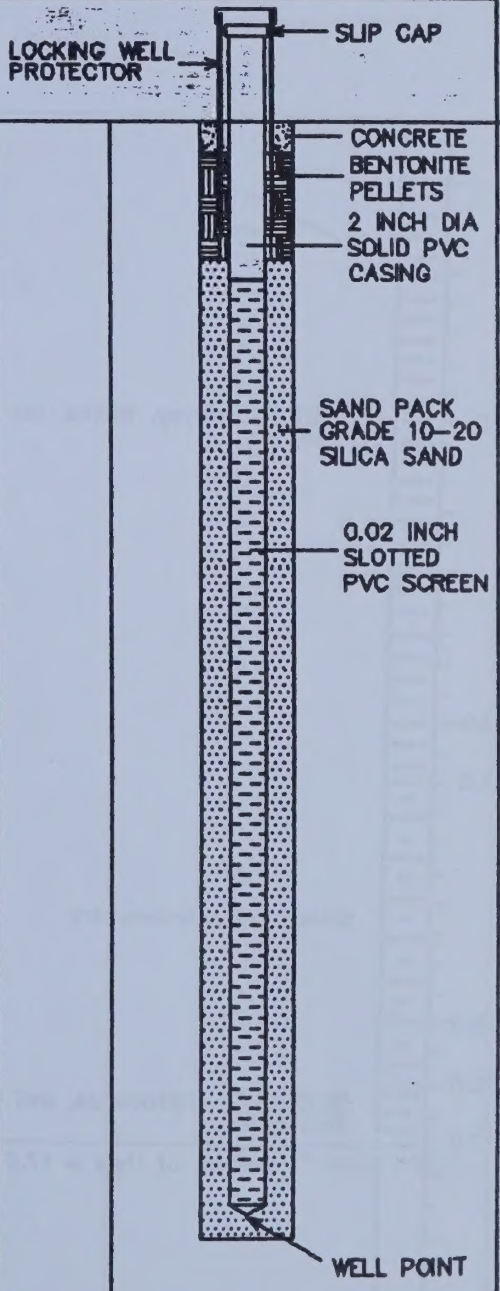
LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL
JOB NO: 94-657
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER
DRILLED BY: W. NIEMI
LOGGED BY: D. TYLER
REMARKS: NONE

WELL NO: BTM-2
SHEET NO: 1 OF 1
LOCATION: 25' E OF WELL BT-1
ELEVATION: TOP OF HOLE NOT MEASURED
GROUNDWATER
DATE: HOLE STARTED 10/10/94
COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)
		SILTSTONE; sandy, clayey, friable, brown, dry			
4.0		SHALE; dark gray, dry, white crystals of alkali salts or calcite			
5.0		SILTSTONE; argillaceous, well-cemented, brown			
7.5					
10.0		SHALE; silty, brown, dry			
15.0					
18.5		Bottom of Hole = 18.5 feet			

WELL COMPLETION


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

Huntingdon

Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL

JOB NO: 94-657
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER

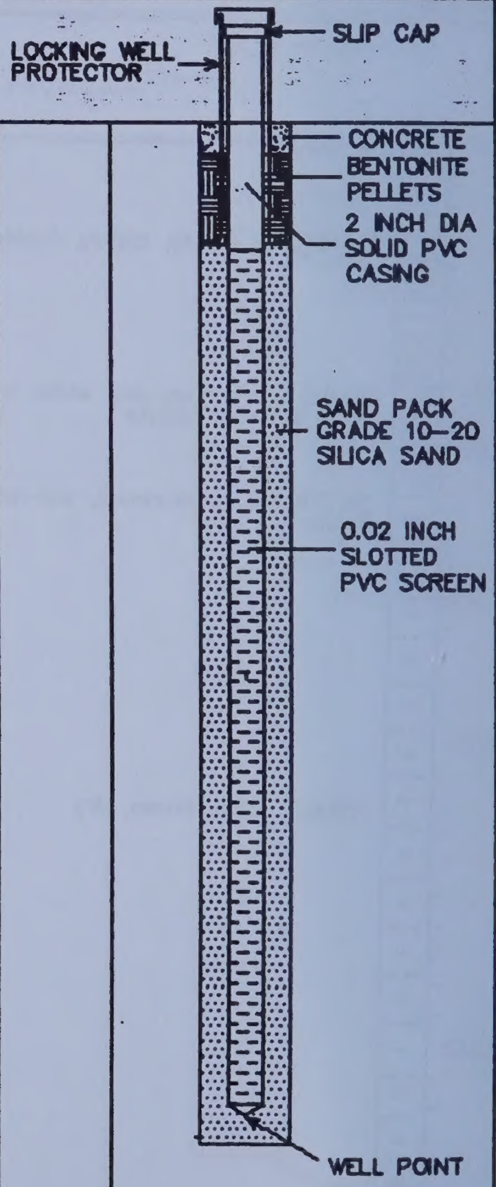
DRILLED BY: W. NIEMI
LOGGED BY: D. TYLER
REMARKS: NONE

WELL NO: BTM-3
SHEET NO: 1 OF 1
LOCATION: 200' SW OF WELL BT-4

ELEVATION: TOP OF HOLE NOT MEASURED
GROUNDWATER

DATE: HOLE STARTED 10/10/94
COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
5.0		SILTSTONE; clayey, friable, tan to brown, dry				
10.0						
11.0						
		SHALE; silty, brown, dry				
15.0						
16.0						
		SILTSTONE; argillaceous, well cemented, dark brown				
17.0		Bottom of Hole = 17.0 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

Huntingdon

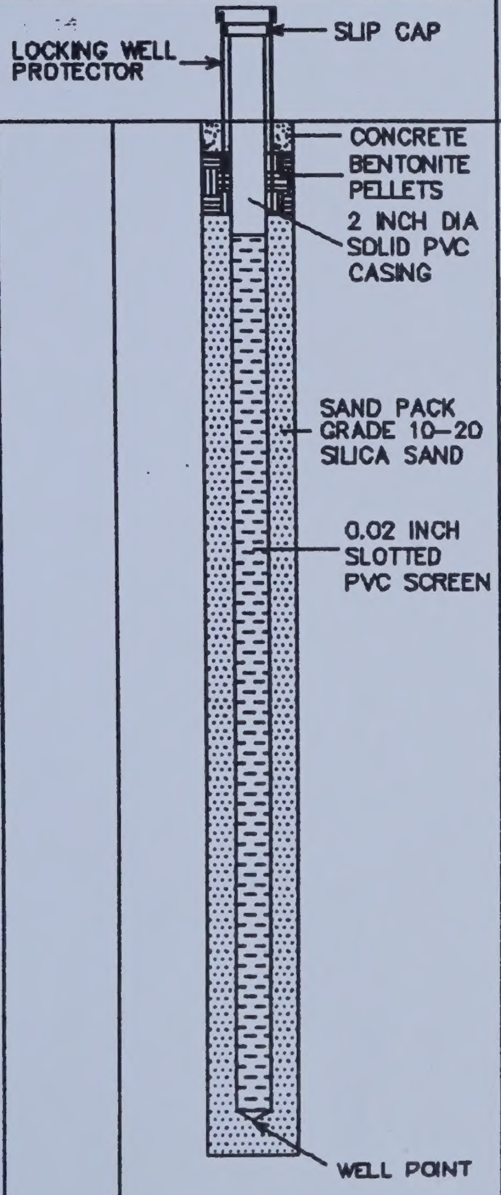
Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL
JOB NO: 94-657
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER
DRILLED BY: W. NIEMI
LOGGED BY: D. TYLER
REMARKS: NONE

WELL NO: BTM-4
SHEET NO: 1 OF 1
LOCATION: 175' E OF WELL BT-2
ELEVATION: TOP OF HOLE NOT MEASURED
GROUNDWATER
DATE: HOLE STARTED 10/10/94
COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
		SILTSTONE; clayey, friable, brown, dry				
5.0						
		SILTSTONE; argillaceous, well cemented, brown, dry				
10.0						
14.5						
15.0		SILTSTONE; friable, tan, dry				
17.0		Bottom of Hole - 17.0 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

TETRA TECH

TF 44/5

Stepp, Tim Stepp 7/15/2013

From: Stepp, Tim
Sent: Monday, July 15, 2013 10:28 AM
To: 'City of Big Timber'
Cc: O'Hern, Kathleen
Subject: RE: Howie Road Landfill

Please log and file. Closure. Thx

Hi Gayle,

Please apologize to Rick. Our inspectors are very busy, but they are informed of the situation. As far as I know, Kathy O'Hern (406.444.9879) will soon be heading that way when it fits into her mid-summer circuit and inspection timing. She will contact Rick before she visits the facility.

Please thank Rick again for the telephone discussion informing DEQ of his concerns regarding post closure maintenance. As I said then and in the letter, we are not expecting revegetation of undisturbed areas or outcrops, only areas affected by solid waste operations. A site inspection should help to identify those areas, especially with regard to the final cover and burn pit as noted.

Thanks for your patience.

Tim

TIM STEPP
Environmental Engineer - Solid Waste Program
Waste & Underground Tank Management Bureau
Permitting & Compliance Division

Montana Department of
ENVIRONMENTAL QUALITY

Lee Metcalf Building
1520 East Sixth Ave
P.O. Box 200901
Helena, MT 59620-0901

Phone 406-444-4725
Fax 406-444-1374
email: tstepp@mt.gov

From: City of Big Timber [mailto:citybtmt@ttc-cmc.net]
Sent: Thursday, July 11, 2013 4:09 PM
To: Stepp, Tim
Subject: Howie Road Landfill

On June 5th the Big Timber Public Works Director called you, relative to your letter of May 30, 2013 requesting a Final Cover Repair Plan. He has concerns about your department expecting any kind of cover to grow on a shale ridge, especially with the winds we have in this area, and no water source available. He asked that you send someone to Big Timber to inspect the site with him and see where his concerns lie. He said that you told him you

would have someone from your department visit the landfill with him. That was 36 days ago, and we have not seen or heard from anyone yet. We have a lot of projects in the works and we would like to get this taken care of before it gets pushed to the back burner. Please let me know what date and time your representative will be available in Big Timber to inspect the site and offer suggestions on how to comply with your request for a Final Cover Plan.

Sincerely,

Gayle McPherson
Clerk/Treasurer
Big Timber, MT 59011
406-932-5611
citybtmt@ttc-cmc.net

308

ORIGINAL

POST-CLOSURE CARE PLAN
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA

RECEIVED

OCT 04 2001

MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

MAXIM
TECHNOLOGIES INC

POST-CLOSURE CARE PLAN
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA

POST-CLOSURE CARE PLAN
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA

Prepared for:

City of Big Timber
P.O. Box 416
Big Timber, Montana 59011

Prepared by:

Maxim Technologies, Inc.
P.O. Box 30615
Billings, Montana 59107

Maxim Project No. 9731053.100

September 2001

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1.2 Facility History 1
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Figure 2 Site Map and Monitoring Locations

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APPENDICES

Appendix A: Monitor Well Logs

1.0 INTRODUCTION

This post-closure care plan for the Big Timber Sanitary Landfill near Big Timber, Montana satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531. This plan was prepared by Maxim Technologies, Inc. (Maxim) for the City of Big Timber. A closure plan was prepared and submitted to Montana Department of Environmental Quality (MDEQ) in April 1998.

1.1 Facility Description

The Big Timber Sanitary Landfill is located in the north half of Section 8, Township 1 North, Range 15 East, Sweetgrass County, Montana (Figure 1). The permitted size of the landfill is 80 acres and the design life was 60 years. Approximately 10 acres in the southwest portion of the site have been disturbed.

The landfill is located on gently sloping rangeland, approximately one-half mile north of the Yellowstone River flood plain. The hydrogeologic setting at this site consists of water bearing sandstone and mudstone interbedded in non-water bearing shale of the Cretaceous Hell Creek Formation. Approximately ten feet of silty clay overlies the Hell Creek bedrock sediments in the northeastern two-thirds of the site. The Hell Creek sediments consist of primarily mudstone (shale) with stringers of sandstone and siltstone. Groundwater is primarily encountered in the sandstone and flows in a southwesterly direction under a gradient that varies from approximately 2.5 percent in the central portion of the landfill property to approximately 6.7 percent in the southwestern portion downgradient of the former waste cell and burn pit.

1.2 Facility History

The Big Timber Sanitary landfill received approximately 2,000 tons of waste per year from 1992 until 1997 that was placed in one cell in the southwestern portion of the site. The cell measures approximately 10 feet by 60 feet by 20 feet deep. The landfill stopped accepting waste and closed in April 1997.

The landfill currently has a network of seven groundwater monitor wells (Figure 2). Four monitor wells were installed in 1989, two wells were installed in 1990, and one well was installed in 1995. Groundwater monitoring was first conducted in 1994 and continued to present. Four methane monitor wells were installed in 1994 (Figure 2). Methane monitoring was first conducted in 1994. A landfill closure plan was written in 1998 (Maxim Technologies, Inc., 1998). The closure plan was implemented in 1999.

1.3 Landfill Closure

The landfill was closed according to the 1998 Closure Plan (Maxim Technologies, Inc., 1998). Specifically, sandy clay loam with a permeability of 9×10^{-6} centimeters per second was placed and compacted to a depth of 18 inches over the landfill waste cell. On-site stockpiled seedbed material

(topsoil) was placed over the cover material to an approximate depth of six inches. Seeding was done in May 1999 using a mixture of native seeds at the following rate:

- Western wheatgrass (1.5 pounds per acre)
- Streambank wheatgrass (1.25 pounds per acre)
- Bluebunch wheatgrass (1.75 pounds per acre); and
- Slender wheatgrass (1.5 pounds per acre).

In January 2001, a deed restriction was filed with the Sweetgrass County (Montana) Clerk and Recorder listing the city property in the north half of Section 8, Township 1 North, Range 15 East, Sweetgrass County, Montana as having been used as a municipal Class II landfill.

2.0 FACILITY CONTACT

The facility contact is:

Mr. William Littell
Director of Public Works
City of Big Timber
P.O. Box 416
Big Timber, Montana 59011
406-932-5646

3.0 DESCRIPTION OF MONITORING AND MAINTENANCE ACTIVITIES

3.1 Landfill Cover Maintenance

Periodic inspections of the landfill cover have been conducted by the City of Big Timber. Future inspection shall be conducted on a semi-annual basis with one inspection in the spring and the second inspection in late summer beginning in 2001 through 2003. Annual inspections shall be made in the spring of each year from 2004 through 2011. The inspector shall document the condition of the vegetative cover (i.e., vegetation density, sod cover, bare spots, etc.), appearance of any erosion of the vegetative cover, condition of the perimeter fence, and overall general appearance of the landfill site.

If the vegetative cover is thin or large bare spots occur, the affected cover areas will be repaired and reseeded according to the Big Timber Landfill closure plan (Maxim Technologies, Inc., 1998). Erosion to the cover will also be repaired according to the Big Timber Landfill closure plan.

3.2 Leachate Collection System Maintenance

Leachate was not generated during the life span of the operating landfill and a leachate collection system was not designed or built. Therefore, future leachate collection maintenance will not be conducted.

3.3 Groundwater Monitoring

Groundwater monitoring has been conducted at the Big Timber Sanitary Landfill since 1994 to present. The groundwater monitoring network consists of seven monitor wells, four upgradient (BT-2, BT-3, BT-4, and BT-5) and three downgradient of the waste cell and burn pit (BT-1S, BT-6, and BT-7; Figure 2). The monitor well logs are included as Appendix A.

Groundwater monitoring has consisted of measuring water levels in all wells and preparing a groundwater potentiometric surface map. Groundwater samples were analyzed for the parameters listed in ARM 17.50.708(a)(iv)(I). Volatile organic constituents have never been detected in any landfill sample. Statistical analysis was conducted on the inorganic groundwater sampling results comparing upgradient results to downgradient results. The most recent groundwater monitoring report concludes that future groundwater monitoring is not necessary (Maxim Technologies, Inc., 2001). However, one additional groundwater monitoring event will be conducted in the spring of 2003. This event will be conducted similar to the April 2001 Big Timber Sanitary Landfill groundwater monitoring event (Maxim Technologies, Inc., 2001).

3.4 Methane Gas Monitoring

Methane gas monitoring has been conducted at the Big Timber Sanitary Landfill since 1994 to present. A summary of the methane monitoring results is shown on Table 1. The percent lower explosive limit (LEL) was used to monitor for potential methane gas in the four gas monitor wells (BTM-1 through BTM-4; Figure 2), the landfill building, and the leachate collection system riser.

Concentrations of explosive gases were zero to two percent, which is which is well below the explosive limit of 100 percent. The most recent explosive gas measurements were conducted during April 2001 and explosive concentrations were zero. Since the landfill is not located near any human occupied structures and gases in the explosive range have not been measured, future methane gas monitoring is not planned.

TABLE 1
METHANE GAS MONITORING RESULTS
BIG TIMBER SANITARY LANDFILL

MONITOR POINT	OCTOBER 1994 (percent LEL)	JANUARY 1995 (percent LEL)	APRIL 1995 (percent LEL)	JULY 1995 (percent LEL)	OCTOBER 1995 (percent LEL)	JANUARY 1996 (percent LEL)
BTM-1	2	<1	<1	<1	<1	<1
BTM-2	<1	1	<1	<1	<1	<1
BTM-3	1	1	1	<1	<1	<1
BTM-4	<1	1	<1	<1	<1	<1
Building	NA	1	<1	1	<1	<1

LEL = lower explosive limit
NA = not analyzed
< = less than

4.0 POST-CLOSURE CARE PERIOD

The post-closure period shall be ten years. Inspections of the landfill will be made during this period. One groundwater monitoring event will be conducted in the spring of 2003. The closed portion of the landfill property (i.e., the former landfill waste cell) will not be used for any activity during the post-closure care period.

5.0 POST-CLOSURE CARE COST ESTIMATE

Post-closure care costs for the entire post-closure care period have been estimated in current dollars based on the activities presented in this post-closure care plan. The estimated costs are shown on Table 2.

TABLE 2
POST-CLOSURE CARE PLAN COST ESTIMATE
BIG TIMBER SANITARY LANDFILL
BIG TIMBER, MONTANA
SEPTEMBER 2001

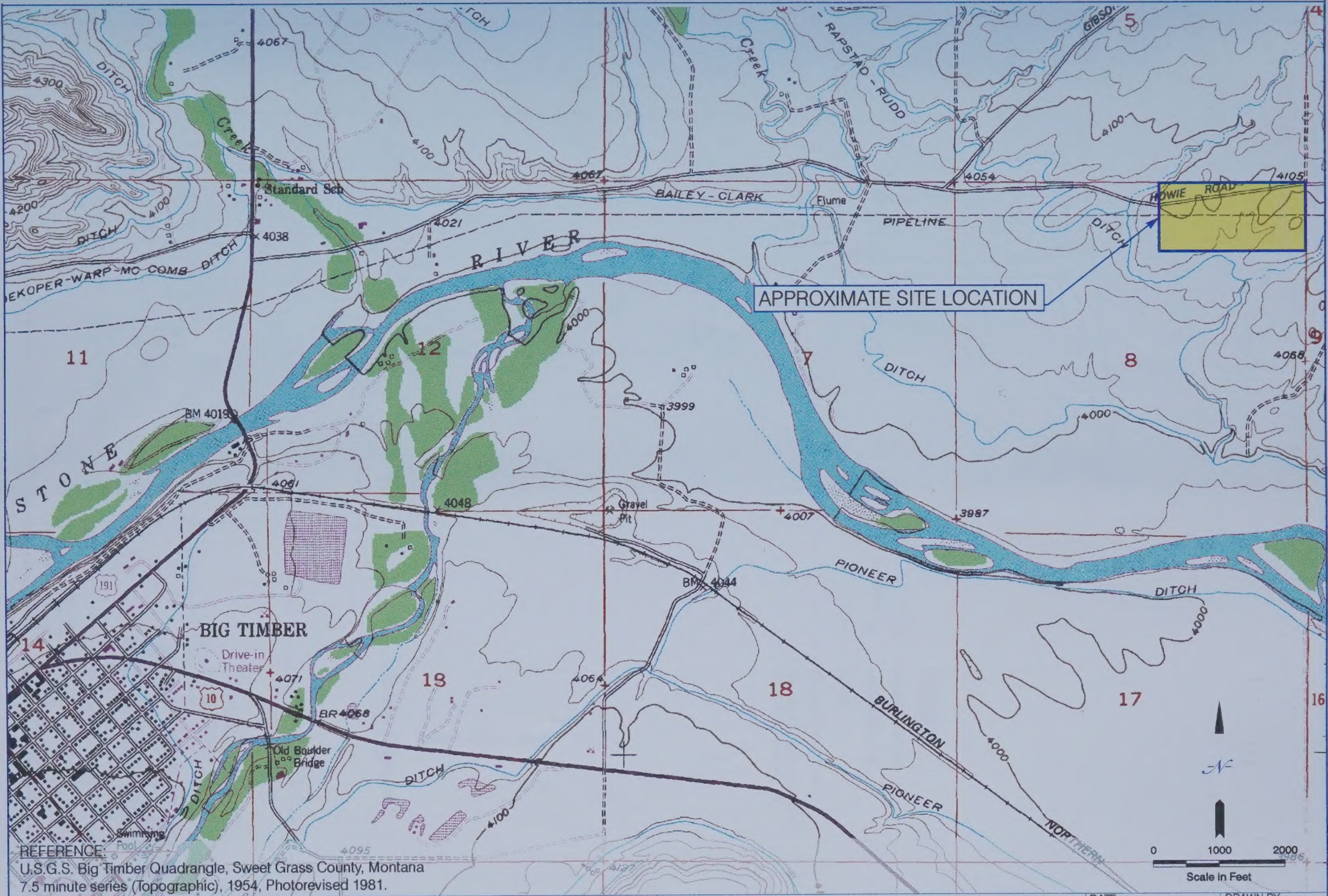
TASK	QUANTITY	RATE	COST
Landfill Inspections			
Cost per inspection			
Project Scientist, per hour	5	65.00	325.00
Vehicle, per mile	180	0.45	81.00
Inspection Subtotal			$406.00
Total Inspection Costs	14	406.00	**$5,684.00**
Groundwater Monitoring Event			
Sampling			
Project Scientist, per hour	2	65.00	130.00
Senior Technician, per hour	8	45.00	360.00
Landfill volatile organics, per sample	7	200.00	1,400.00
Landfill volatile inorganics, per sample	5	225.00	1,125.00
Sampling disposable materials, per sample	7	15.00	105.00
Disposable metals filter, per sample	5	22.00	110.00
Peristaltic pump rental, per day	1	25.00	25.00
Groundwater sampling instrument rental, per day	1	75.00	75.00
Vehicle, per mile	180	0.45	81.00
Reporting			
Data management and report preparation, per hour	20	65.00	1,300.00
Senior review, per hour	2	75.00	150.00
Drafting, per hour	2	50.00	100.00
Clerical, per hour	2	45.00	90.00
Total Groundwater Monitoring			**$5,051.00**
Total Post-Closure Care Cost			**$10,735.00**

6.0 REFERENCES CITED

Maxim Technologies, Inc., 1998. Closure Plan, Big Timber Landfill, Big Timber, Montana. Unpublished document submitted to the City of Big Timber, Montana. April.

Maxim Technologies, Inc., 2001. April 2001 Groundwater Monitoring Results, Big Timber Sanitary Landfill, Big Timber, Montana. Unpublished document prepared for City of Big Timber, Montana. August.

FIGURES


APPROXIMATE SITE LOCATION
HOWIE ROAD
BAILEY - CLARK
PIPELINE
Flume
RAPSTAD - RUDD
Creek
GIBSON
RIVER
STONE
DEKOPER-WARP-MC COMB DITCH
DITCH
Standard Sch
Creek
BIG TIMBER
Drive-in Theater
Old Boulder Bridge
Swimming Pool
Gravel Pit
PIONEER DITCH
PIONEER
BURLINGTON NORTHERN
BM 4019
BM 4044
BR 4068
4067
4300
4200
4100
4038
4021
4054
4105
4000
3999
4061
4048
4007
3987
4068
4071
4064
4095
4127
11
12
13
14
18
17
16
7
8
9
5
4
191
10
0
1000
2000
Scale in Feet
N

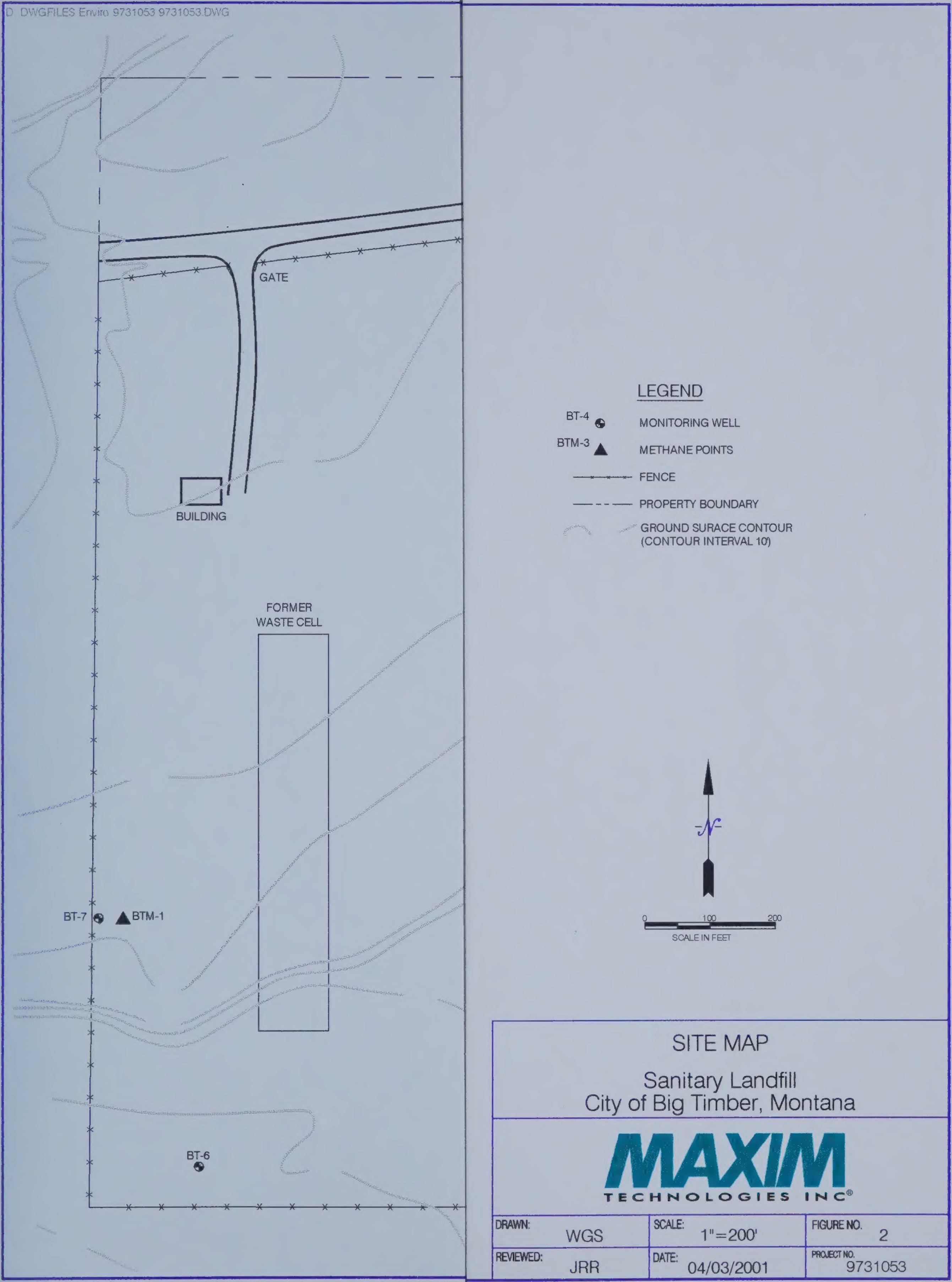
REFERENCE:
U.S.G.S. Big Timber Quadrangle, Sweet Grass County, Montana
7.5 minute series (Topographic), 1954, Photorevised 1981.

MAXIM
TECHNOLOGIES INC®

SITE LOCATION MAP

City Of Big Timber Sanitary Landfill
Sweet Grass County, Montana

DATE: 04/03/2001	DRAWN BY: WGS
REVIEWED: JRR	SCALE: 1"=2000'
PROJ. NO.: 9731053	FIGURE NO.: 1

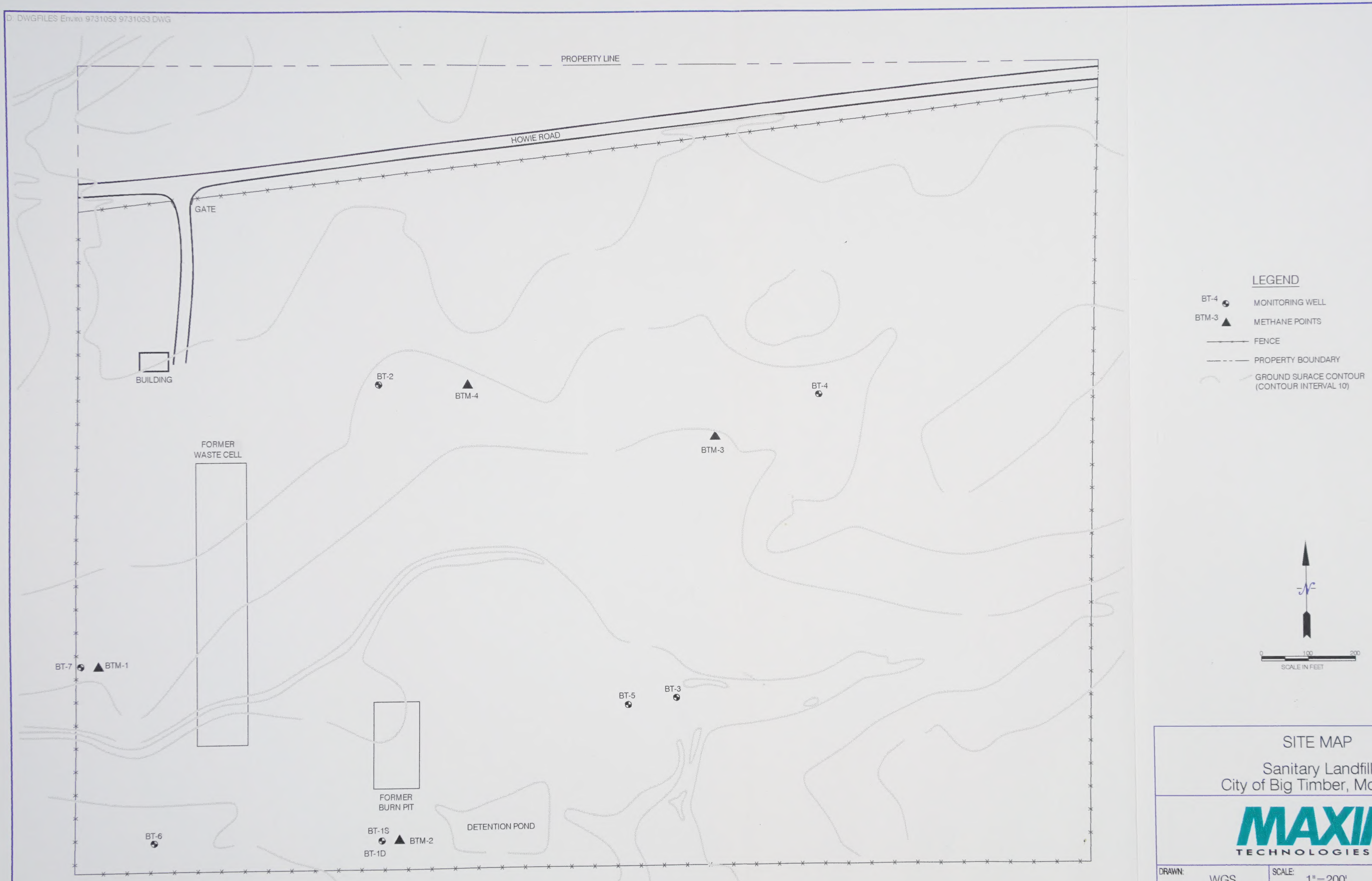

D: DWGFILES Enviro 9731053 9731053.DWG
GATE
BUILDING
FORMER WASTE CELL
BT-7
BTM-1
BT-6
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
GROUND SURACE CONTOUR (CONTOUR INTERVAL 10')
N
0
100
200
SCALE IN FEET

SITE MAP

Sanitary Landfill
City of Big Timber, Montana

MAXIM
TECHNOLOGIES INC®

DRAWN: WGS	SCALE: 1"=200'	FIGURE NO. 2
REVIEWED: JRR	DATE: 04/03/2001	PROJECT NO. 9731053


D: DWGFILES Enviro 9731053 9731053.DWG
PROPERTY LINE
HOWIE ROAD
GATE
BUILDING
BT-2
BTM-4
BT-4
BTM-3
FORMER WASTE CELL
BT-7
BTM-1
BT-5
BT-3
FORMER BURN PIT
DETENTION POND
BT-6
BT-1S
BTM-2
BT-1D
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
GROUND SURACE CONTOUR (CONTOUR INTERVAL 10)
N
0
100
200
SCALE IN FEET

SITE MAP

Sanitary Landfill
City of Big Timber, Montana

MAXIM
TECHNOLOGIES INC®

DRAWN: WGS	SCALE: 1"=200'	FIGURE NO. 2
REVIEWED: JRR	DATE: 04/03/2001	PROJECT NO. 9731053

APPENDIX A

Monitor Well Logs

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-1 shallow & deep

Legal Location: T 1N R 15E Sec 8 Tract ABDD Descriptive Location: 400′ west of draw, downgradient of proposed L.F.

Recorded By: D. Hazen Hole Started: Time: 1045 Date: 05/23/89 Hole Completed: Time: 1545 Date: 05/23/89 Driller: Rock Creek Drilling, Bill Kupfner

Drill Method: Rotary Drilling Fluids Used: Air Pilot Hole Diameter: 8" to 9′ Drilled Hole Diameter: 6"

Total Depth Drilled: 80′ Total Depth Reamed: _____ Total Depth Cased Below G.S.: _____ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 35.5-25.5 68.5-58.5 Target Aquifer: Fox Hills Formation Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	x	
Well Test Pumped?		x
Water Samples Taken?		x
Material Samples Taken?	x	
E-Logs?		x

Method Perforated or Screened

_____	No casing in hole
_____	Open bottom
_____	Slotted with Mill's Knife
_____	Slotted with a torch
_____	Screened by pulling casing
_____	Field saw cut
x	Mechanical slots 0.030 (size)
_____	Other (specify) _____

Static Fluid Level Below Measuring Point:	Date/Time Measured:
18.40	06/01/89 @ 0850
18.75	05/24/89 @ 0839
19.27′	05/23/89 @ 1734

Measuring Point Description/Elevation: Top of steel well protector, +2.82 ft. MP Height Above (+/-) or Below G.S.: +2.82′

Well Annulus Completion Description: Dual Completion: 80′-72′, cuttings; 72-71.5′, Wyo-Ben bentonite; 71.5′-56.6′, 10-20 Colorado Silica Sand; 56.6′-38′, Wyo-Ben Bentonite (medium); 38′-22′, 10-20 Colorado Silica Sand; 22′-11′, Wyo-Ben Bentonite (medium)

Well Development Description: Bailed 15 gallons from both the shallow and deep wells; performed bailer Recovery Test on each well.

Remarks: 7" steel surface casing installed to 9 ft. below ground surface. Volclay bentonite pellets placed from 9′ to 8′ BGS outside of 7" steel and 8′ to 1′ backfilled with clay/shale cuttings, concrete surface seal installed around steel surface casing. Ground surface at BT-1 assumed elevation of 0.0 ft.

DRILLING AND LITHOLOGIC LOG

BT-1

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1′	Topsoil/organic material
1′	27′	Gray clay/shale, friable, minor silt and sand, dry minor organics
27′	28′	Silty sandstone, minor water <0.5 gpm, dark red. No recovery with split spoon sampler.
28′	38′	Sandstone and shale interbedded - dark red - making approximately 2 gallons per minute
38′	60′	Gray shale, dry - sealing off water in upper zone (27 to 38′)
60′	66′	Red sandstone with some shale - making 5-6 gpm
66′	74′	Gray shale
74′	80′	Shale with some red sand interbeds, still making 5-6 gpm

TD = 80′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-2

Legal Location: T 1N R 15E Sec 8 Tract ABAD Descriptive Location: 100′ west of TP-10, 100′ NE of TP-1, upgradient

Recorded By: D. Hazen Hole Started: Time: 1600 Date: 05/23/89 Hole Completed: Time: 1710 Date: 05/23/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air/Water Pilot Hole Diameter: 8" to 9′ Drilled Hole Diameter: 6" to 47′, 4-7/8" 47′-90′

Total Depth Drilled: 90′ Total Depth Reamed: --- Total Depth Cased Below G.S.: 42.4′ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 32.4-42.4 Target Aquifer: Sandstone lenses Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		x
Well Test Pumped?		x
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		x

Method Perforated or Screened
___ No casing in hole
___ Open bottom
___ Slotted with Mill's Knife
___ Slotted with a torch
___ Screened by pulling casing
___ Field saw cut
_x_ Mechanical slots 0.010 (size)
___ Other (specify) ___

Static Fluid Level Below Measuring Point:	Date/Time Measured:
23.64	09/07/89 @ 1130
23.38	06/01/89 @ 1330
29.20	05/24/89 @ 0830
46.62	05/23/89 @ 1713

Measuring Point Description/Elevation: Top of steel well protector, 125.6 ft. MP Height Above (+/-) or Below G.S.: +2.7′

Well Annulus Completion Description: 90 - 47′, cuttings; 47′ - 43′, Bentonite chips; 43′ - 30′, 10-20 Colorado Silica Sand; 30′ - 16′, Volplug Bentonite chips

Well Development Description: 9/8/89 - bailed approximately 25 gallons

Remarks: 7" steel surface casing installed to 9′ BGS with bentonite seal. Measuring Point Elevation determined by level survey; Datum (0.0′) is ground surface at well BT-1, well deepened from 47.2′ to 90′ on 9/7/89

SC = 580, T = 11 C, pH = 9.1

DRILLING AND LITHOLOGIC LOG

BT-2

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	15′	Overburden, gray silt with clay, ocassional boulder, slightly moist
15′	21′	Brown to light brown shale, friable, dry
21′	25′	Brown shale, friable, dry
25′	40′	Light gray to brown mudstone, dry
40′	42′	Light purple to gray, clay/shale, slightly moist
42′	47.2	Light gray to brown mudstone, slightly moist
47.2′	55′	Gray sandy shale, very hard drilling, several soft intervals
55′	65′	Gray clay shale, friable, easier drilling, let well recover at 59 ft. for 10 minutes, slight amount of water, no noticeable increase from 47′
65′	70′	Shale/mudstone, dark gray, hard drilling
70′	79′	Clay/shale, soft., slight amount of water, no noticeable increase from 47′, hard drilling 76′ - 77′ and 78′ - 78.5′
79′	90′	Clay shale/mudstone, gray and gray brown, let sit at 90′ - very slight amount of water, no noticeable increase from 47′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-3

Legal Location: T 1N R 15E Sec 8 Tract AACD Descriptive Location: 230′ SE of Test Pit 12, 30′ N of draw at S edge of site

Recorded By: D. Hazen Hole Started: Time: 1440 Date: 09/07/89 Hole Completed: Time: 1600 Date: 09/07/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air/Water Pilot Hole Diameter: 8" Reamed Hole Diameter: 4 3/4"

Total Depth Drilled: 21′ Total Depth Reamed: _____ Total Depth Cased Below G.S.: 20.7′ Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 7.7 - 17.7 Target Aquifer: Alluvial Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		
Well Test Pumped?		
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		

Method Perforated or Screened

	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
x	Mechanical slots 0.010 (size)
	Other (specify) _____

Static Fluid Level Below Measuring Point: 14.67′ / 14.81′ Date/Time Measured: 09/08/89 @ 1145 - after overnight stablization / 09/07/89 @ 1618

Measuring Point Description/Elevation: Top of steel surface casing MP Height Above (+/-) or Below G.S.: +1.5′

Well Annulus Completion Description: 20.7 - 7.0′, 10-20 Colorado Silica Sand; 7.0 - 5.5, volplug bentonite chips.

Well Development Description: Bailed approximately 20 gallons - would not go dry

Remarks: 11.5′ 7" steel surface casing installed to 9.5′, sealed with Volplug bentonite 1/4" pplets

SC = 1574, T = 11 C

PH = 7.9 @ 11 C

DRILLING AND LITHOLOGIC LOG

BT-3

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1′	Topsoil
1′	3′	Sand with silt, brown
3′	12′	Clay with minor fine sand and silt, slightly moist, dark brown, firm
12′	14′	Sand/gravel - possible sandstone lense, wet
14′	17′	Clay with silt and firm sand, brown
17′	20′	Clay, minor silt, slightly moist
		Making approximately 2 gpm at 20′
		TD - 20′

Chen-Northern, Inc.

WELL COMPLETION LOG

State: Montana County: Sweetgrass Project: Big Timber Landfill Hole Name or Number: BT-4

Legal Location: T 1N R 15E Sec 8 Tract AACA Descriptive Location: Northwest of landfill site in small draw

Recorded By: D. Hazen Hole Started: Time: 1600 Date: 09/07/89 Hole Completed: Time: 1715 Date: 06/07/89 Driller: Rock Creek, Kupfner

Drill Method: Rotary Drilling Fluids Used: Air Pilot Hole Diameter: 8" Reamed Hole Diameter: 4-3/4"

Total Depth Drilled: 50' Total Depth Reamed: ______ Total Depth Cased Below G.S.: 43.2' Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 38.2 - 28.2 Target Aquifer: Mudstone Beds Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?		
Well Test Pumped?		
Water Samples Taken?	x	
Material Samples Taken?	x	
E-Logs?		

Method Perforated or Screened

	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
x	Mechanical slots 0.010 (size)
	Other (specify) ______

Static Fluid Level Below Measuring Point: 16.62' Date/Time Measured: 09/08/89 @ 900
32.40' 09/07/89 @ 1921

Measuring Point Description/Elevation: Top of steel surface casing MP Height Above (+/-) or Below G.S.: +2.0'

Well Annulus Completion Description: 50' - 41', caved material; 41' - 23', 10-20 Colorado Silica Sand; 23' - 8' Volplug medium chips Bentonite

Well Development Description: Bailed approximately 20 gallons - let recover
SWL = 38.6' after bailing dry
29.5 1056 approximately 5 minutes later

Remarks: 11.5' surface casing installed with bentonite chip seal.
pH = 8.1 , T = 10.5 C
SC = 1307

DRILLING AND LITHOLOGIC LOG

BT-4

(Depth Below G.S.)

From	To	DRILLING LOG — Geological, Drilling, and Water Conditions and Sampling
0	2′	Silty sand, brown
2′	10′	Clay with minor silt, dark gray brown
10′	10.5′	Hard sandstone
10.5′	20′	Clay/shale - dry - slightly moist, gray brown
20′	34′	Clay - very hard; dry and dusty, light gray, hard
34′	39′	Slightly moist, clay with mudstone clasts.
39′	41′	Clay, brown, very moist No standing water @ 40′ - wet cuttings
41′	50′	Clay, light gray, hard, dry and dusty

(Water on drill steel - 16′ off bottom)

TD - 50′

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO.: 89-3020.L

PROJECT: Big Timber Landfill STATE: MT COUNTY: Sweetgrass WELL NO.: BT-5

LEGAL LOCATION: T 1N R 15E S 8 TRACT AACD

DESCRIPTIVE LOCATION: 170' West, 20' North of BT-3

DATE STARTED: 7/19/90 DATE COMPLETED: 7/19/90 DRILLING COMPANY/ DRILLER: ESD/Ed Hillman LOGGED BY: D. Hazen

DRILLING METHOD: Rotary BOREHOLE DIAMETER (In): 5 7/8" DRILL FLUIDS USED: Air

TOTAL DEPTH DRILLED (ft): 31' TOTAL DEPTH CASED (ft): 29' INTERVAL PERFORATED OR SCREENED (ft): from: 24.0 to: 29.0 DIAMETER AND TYPE OF CASING: 2" PVC, Sch 40

METHOD OF PERFORATION:
___ Open Hole
___ Open Bottom
___ Saw Slotted
X Mechanical Slots 0.020 (size)
___ OTHER (specify) ___

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
WELL DEVELOPED	X	
WELL PUMPED		X
WATER SAMPLES COLLECTED		X
MATERIAL SAMPLES COLLECTED	X	

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: Length 15 ft Diam. 6"
LOCK NO.: 2265

SURFACE SEAL:	Type: Concrete	from: 0	to: 0.5
BACKFILL:	Material: Bentonite	from: 7 ft	to: 21 ft
FILTER PACK:	Type: 10-20 Silica	from: 21 ft	to: 30 ft

STATIC WATER LEVEL: 18.45 MEASURING POINT DATE: 7/20/90 DESCRIPTION/ ELEVATION: Top of steel well protector, N side at mark, 4069.25 ft MEASURING POINT RELATIVE TO GROUND SURFACE (+/-): +2.7'

REMARKS: 12.3' of 6" Steel casing installed in boring below ground surface. Finished boring at 1100 hours. Cuttings/caved material from 30 to 31 ft.

INTERVAL (FT) below ground surface	LITHOLOGIC DESCRIPTION	REMARKS
0-8'	Silt, Clay and Sand, light brown	dry
8-10'	Sandstone lense, gray, fine grained	hard drilling
10-15'	Silty Clay, gray to reddish brown, minor sand	slightly moist
15-16'	Sandstone, light gray brown, medium grained	dry
16-19.5'	Silty clay, reddish brown, minor sand	slightly moist - let sit at 17.5' for 5 minutes, dry
19.5-20'	Sandstone lense	dry
20-26	Silty clay, gray	slightly moist to 25', very moist at 25'
26-27'	Sandstone, dark gray, medium to fine grained	Making 1/2 - 1/4 gpm water
27-31'	Silty clay, gray	slightly moist

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO.: 89-3020.L

PROJECT: Big Timber Landfill STATE: MT COUNTY: Sweetgrass WELL NO.: BT-6

LEGAL LOCATION: T 1N R 15E S 8 TRACT ABDD

DESCRIPTIVE LOCATION: 500 feet west of BT-1

DATE STARTED: 7/19/90

DATE COMPLETED: 7/19/90

DRILLING COMPANY/ DRILLER: ESD/Ed Hillman

LOGGED BY: D. Hazen

DRILLING METHOD: Rotary

BOREHOLE DIAMETER (In): 5 7/8

DRILL FLUIDS USED: Air

TOTAL DEPTH DRILLED (ft): 37'

TOTAL DEPTH CASED (ft): 25'

INTERVAL PERFORATED OR SCREENED (ft): from: 25.0 to: 30.0

DIAMETER AND TYPE OF CASING: 2" PVC, Sch. 40

METHOD OF PERFORATION:
___ Open Hole
___ Open Bottom
___ Saw Slotted
X Mechanical Slots 0.020 (size)
___ OTHER (specify)

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
WELL DEVELOPED	X	
WELL PUMPED		X
WATER SAMPLES COLLECTED		X
MATERIAL SAMPLES COLLECTED	X	

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: Length 10 ft Diam. 6"

LOCK NO.: 2265

SURFACE SEAL: Type: Concrete from: 0 to: 0.5 ft

BACKFILL: Material: Bentonite from: 6' to: 23'

FILTER PACK: Type: 10-20 silica sand from: 23 ft to: 33 ft

STATIC WATER LEVEL: 22.85

DATE: 7/20/90

MEASURING POINT DESCRIPTION/ ELEVATION: Top of Steel Well Protector, N side at mark, 4057.57

MEASURING POINT RELATIVE TO GROUND SURFACE (+/-): +2.3'

REMARKS: 7.7' of 6" steel in ground

INTERVAL (FT) below ground surface	LITHOLOGIC DESCRIPTION	REMARKS
0-2'	Top soil, silty sand, loose, brown	dry
2-6'	Silty clay, brown to gray	dry
6-7'	Clay/Shale layer	hard drilling
7-12'	Silty clay, dark gray, minor sand	
12-22'	Sandy mudstone, light gray	dry, relatively hard drilling
22-26'	Mudstone with sand, dark gray	dry, moist at 26'
26-33'	Sandy Mudstone, dark gray, likely mudstone with sand interbedded	making water at 26-27', and at 29-29.5'
33-37'	Silty clay, reddish brown	slightly moist, slight oil sheen on mud return

Form No. 603 (R 2-89)

WELL LOG REPORT

File No. ____________

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER

WELL BT-7

Name CITY OF BIG TIMBER

2. CURRENT MAILING ADDRESS

P.O. BOX 415
BIG TIMBER, MT. 59011

3. WELL LOCATION

NW ¼ SW ¼ NE ¼ Section 9
Township 1N N/S Range 15 E E/W County SWT GRASS
Govn't Lot ________, or Lot ________, Block ________
Subdivision Name ________
Tract Number ________

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☒ Specify TOR MONITOR

5. TYPE OF WORK:

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole

Dia. 7 7/8 in. from 0 ft. to 5 ft.
Dia. 5 7/8 in. from 5 ft. to 47 ft.
Dia. ____ in. from ____ ft. to ____ ft.

7. CONSTRUCTION DETAILS:

Casing; Steel Dia. 6 from +3 ft. to 7'10" ft.
Threaded ☐ Welded ☒ Dia. ____ from ____ ft. to ____ ft.
Type A-53 Wall Thickness .250
Casing; Plastic Dia. 2 from 2'3" ft. to 47 ft.
Weight S.40IFJ Dia. ____ from ____ ft. to ____ ft.

PERFORATIONS: Yes ☐ No ☒

Type of perforator used ________
Size of perforations ________ in. by ________ in.
________ perforations from ________ ft. to ________ ft.
________ perforations from ________ ft. to ________ ft.
________ perforations from ________ ft. to ________ ft.

SCREENS: Yes ☒ No ☐

Manufacturer's Name MONOFLEX
Type ________ Model No. ________

f) Duration of test: Pumping time ________ hrs.
g) Recovery time ________ hrs.
h) Recovery water level ________ ft. at ________ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? ____ Yes x No
If yes, how? ________

12. WELL LOG

Depth (ft.) From	Depth (ft.) To	Formation
0	1	top soil/S.S. cobbles
1	5	S.S. W/silts, lite brwn
5	9	S.S. W/SILT
9	11	FINE SAND, soft
11	13	fine gray/brwn S.S.
13	27	gray sand/mudstone/hard
27	31	purple/black mudstone/sand/
31	33	hard/fine grain mudstone/pur
33	35	soft/fine grain " "
35	37	soft purple/black sand/fine
37	42	hard purple/black mudstone
42	43	gray S.S. soft water
43	47	purple clay/mudstone

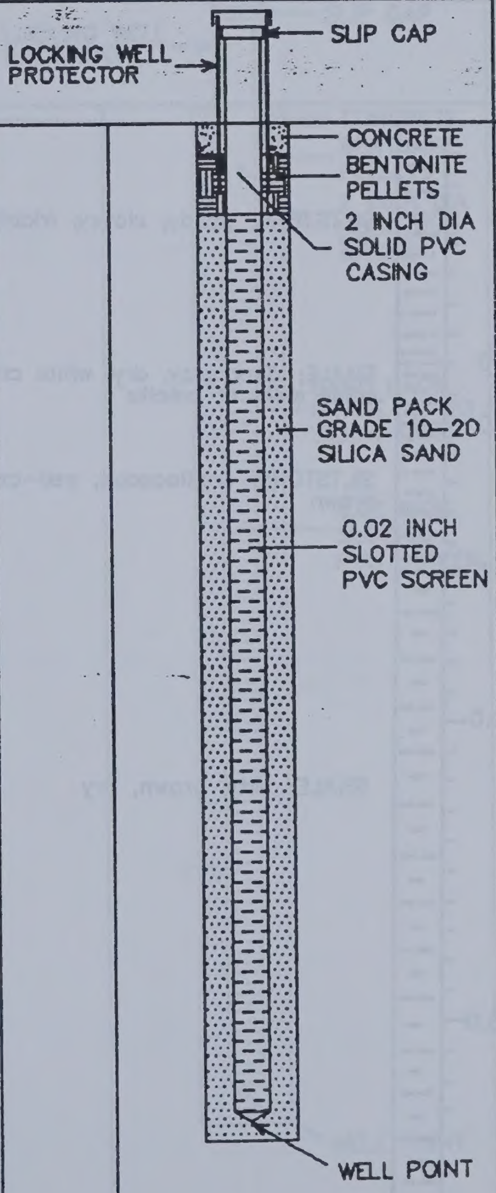
Huntingdon

Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL	WELL NO: BTM-1
	SHEET NO: 1 OF 1
JOB NO: 94-657	LOCATION: 340' N, 50' W OF WELL BT-6
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER	ELEVATION: TOP OF HOLE NOT MEASURED
	GROUNDWATER
DRILLED BY: W. NIEMI	
LOGGED BY: D. TYLER	DATE: HOLE STARTED 10/10/94
REMARKS: NONE	COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
5.0		SANDSTONE; very fine grained, silty, light tan, dry, occasional clayey zones				
10.0						
15.0						
15.5		SILTSTONE; argillaceous, well cemented, brown				
16.5		SANDSTONE				
17.0		Bottom of Hole = 17.0 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

Huntingdon
Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL

JOB NO: 94-657
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER

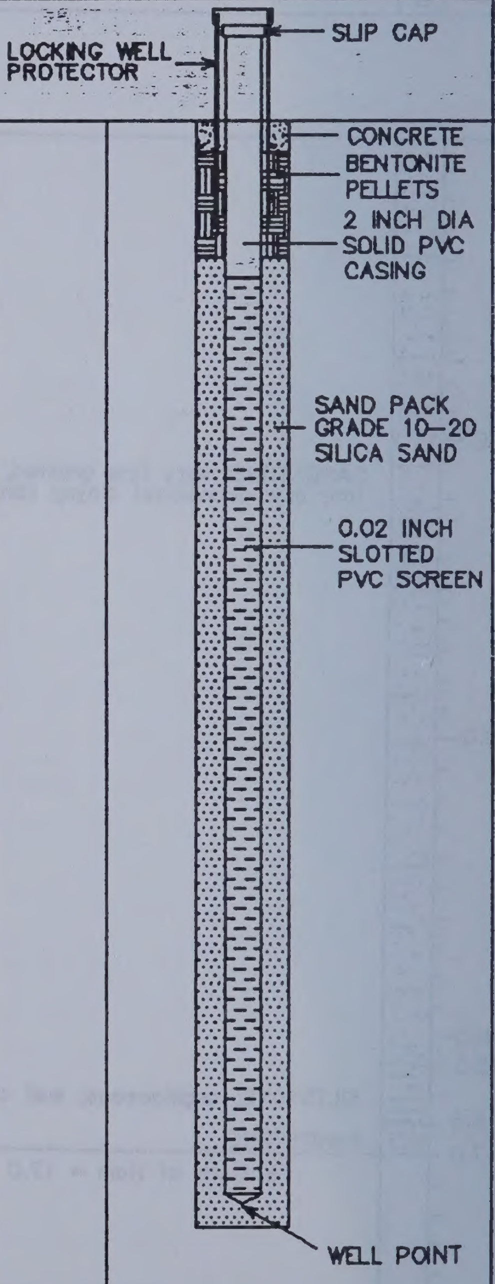
DRILLED BY: W. NIEMI
LOGGED BY: D. TYLER
REMARKS: NONE

WELL NO: BTM-2
SHEET NO: 1 OF 1
LOCATION: 25' E OF WELL BT-1

ELEVATION: TOP OF HOLE NOT MEASURED
GROUNDWATER

DATE: HOLE STARTED 10/10/94
COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
		SILTSTONE; sandy, clayey, friable, brown, dry				
4.0		SHALE; dark gray, dry, white crystals of alkali salts or calcite				
5.0		SILTSTONE; argillaceous, well-cemented, brown				
7.5						
10.0		SHALE; silty, brown, dry				
15.0						
18.5		Bottom of Hole = 18.5 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

Huntingdon

Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL

JOB NO: 94-657

DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER

DRILLED BY: W. NIEMI

LOGGED BY: D. TYLER

REMARKS: NONE

WELL NO: BTM-3

SHEET NO: 1 OF 1

LOCATION: 200' SW OF WELL BT-4

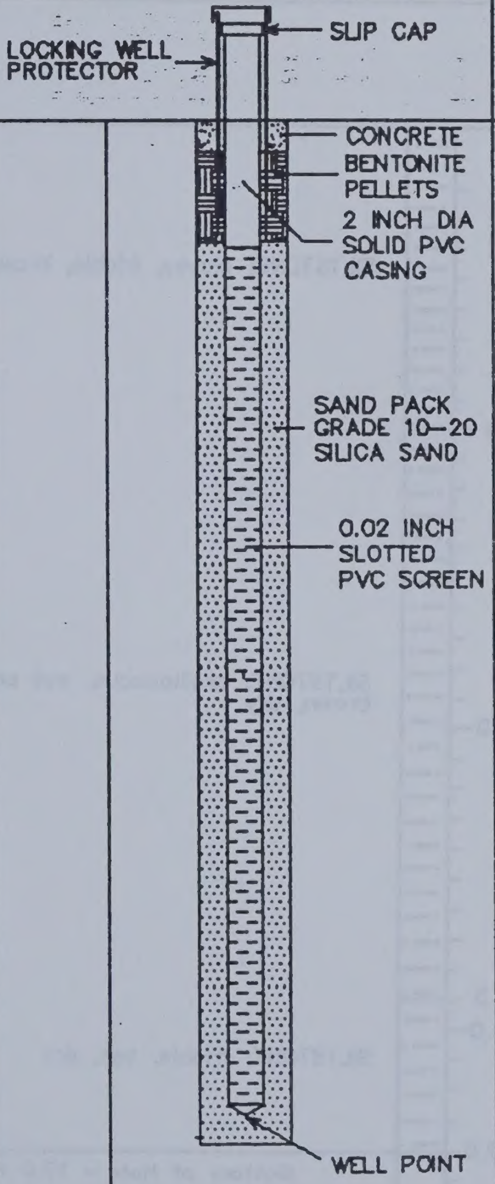
ELEVATION: TOP OF HOLE NOT MEASURED

GROUNDWATER

DATE: HOLE STARTED 10/10/94

COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
5.0		SILTSTONE; clayey, friable, tan to brown, dry				
10.0						
11.0						
		SHALE; silty, brown, dry				
15.0						
16.0		SILTSTONE; argillaceous, well cemented, dark brown				
17.0		Bottom of Hole = 17.0 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

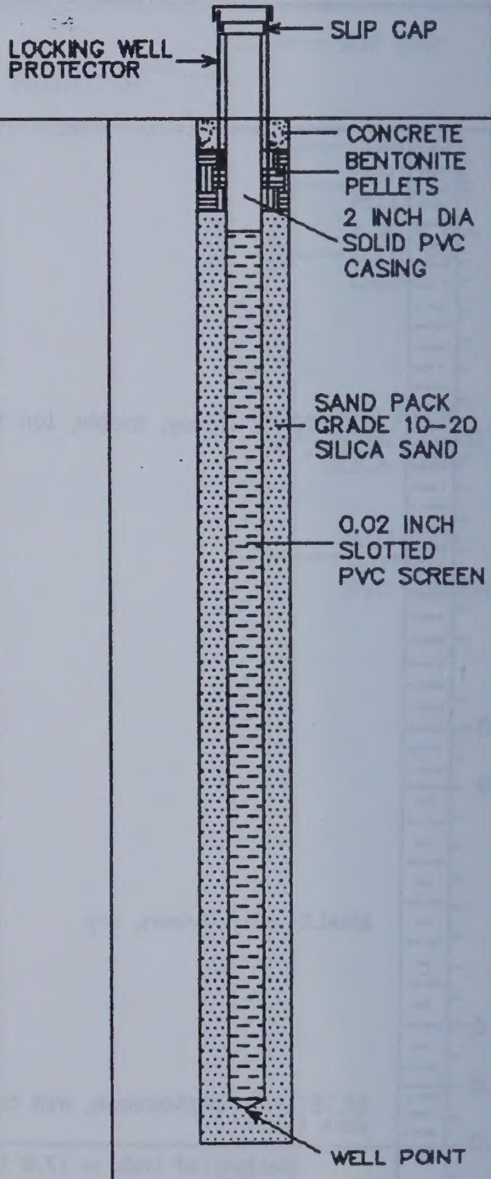
Huntingdon
Engineering & Environmental, INC.

LOG OF METHANE MONITORING POINT

PROJECT: BIG TIMBER SANITARY LANDFILL
JOB NO: 94-657
DRILL TYPE: MOBILE B-53, HOLLOWSTEM AUGER
DRILLED BY: W. NIEMI
LOGGED BY: D. TYLER
REMARKS: NONE

WELL NO: BTM-4
SHEET NO: 1 OF 1
LOCATION: 175' E OF WELL BT-2
ELEVATION: TOP OF HOLE NOT MEASURED
GROUNDWATER
DATE: HOLE STARTED 10/10/94
COMPLETED 10/10/94

DEPTH (FT)	GRAPHIC LOG	CLASSIFICATION AND DESCRIPTION	SAMPLE INTERVAL	S.P.T. (IN) (BLOWS/FT.)	ORGANIC VAPOR CONTENT (ppm)	WELL COMPLETION
		SILTSTONE; clayey, friable, brown, dry				
5.0						
		SILTSTONE; argillaceous, well cemented, brown, dry				
10.0						
14.5						
15.0		SILTSTONE; friable, tan, dry				
17.0		Bottom of Hole = 17.0 feet				


SLIP CAP
LOCKING WELL PROTECTOR
CONCRETE
BENTONITE PELLETS
2 INCH DIA SOLID PVC CASING
SAND PACK GRADE 10-20 SILICA SAND
0.02 INCH SLOTTED PVC SCREEN
WELL POINT

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TECHNOLOGIES INC®

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DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

CLOSURE PLAN
BIG TIMBER LANDFILL

City of Big Timber, Montana
April 27, 1998

MAXIM
TECHNOLOGIES INC

CLOSURE PLAN
BIG TIMBER LANDFILL

City of Big Timber, Montana
April 27, 1998

CLOSURE PLAN FOR BIG TIMBER LANDFILL
BIG TIMBER, MONTANA

Prepared For:
Mr. Ron Thomas
Director of Public Works
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

Prepared By:
Maxim Technologies
P.O. Box 30615
Billings, MT 59107

BRIAN R.
GRANT
7971 PE
4-27-98

April 27, 1998

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3.0 CLOSURE PLAN 1
3.1 LANDFILL COVER DESIGN 1
3.2 CONSTRUCTION REQUIREMENTS 4
3.3 DEED REQUIREMENTS 6

APPENDICES
Appendix A - Figures and Tables
Appendix B - Modeling Results for Landfill Cover Percolation Rates
Appendix C - Soil Testing Results
Appendix D - Revegetation Information

EXHIBITS
Sheet 1 - Site Plan
Sheet 2 - Cell Closure Plan
Sheet 3 - Sections

1.0 INTRODUCTION

At the request of the Big Timber City Council and Staff, Maxim Technologies, Inc. (Maxim) has prepared this closure plan for the Big Timber Landfill. Preparation of the closure plan was completed following requirements provided in the Administrative Rules of Montana (ARM) 17.50. The City of Big Timber is seeking closure of the landfill due to high operating and monitoring costs as compared to other alternatives available to the City. The City is currently having municipal wastes transported by Browning-Ferris Industries to the Gallatin County Landfill located near Logan, Montana.

The closure plan provided herein was prepared to provide a low cost of construction. A more highly engineered closure plan, including such things as a very low permeable liner over the waste, could have been completed. However, costs for construction would be much higher partly because there does not appear to be a suitable on-site borrow source for low permeable cover soil.

2.0 SITE BACKGROUND

The City of Big Timber Landfill site is located approximately 4 miles northeast of the City (Figure 1, Appendix A). Damschen & Associates and Chen-Northern (now Maxim Technologies) provided the landfill design and geotechnical studies. The permitted area of the landfill site is 90 acres and was designed for a 60 year life. Only a few acres in the southwest portion of the site have been disturbed. The site has received approximately 2,000 tons of solid waste per year since 1992 that has been placed in a cell located in the western portion of the site (Figure 2). Landfill operations were ended in April 1997. As mentioned above, BFI was awarded a contract to privatize solid waste collection and disposal.

3.0 CLOSURE PLAN

3.1 LANDFILL COVER DESIGN

Maxim has evaluated several alternative landfill cover designs for closure of the Big Timber Landfill. Cover requirements for closure are described in ARM 17.50.530. Part (1)(a) of the regulations describe the minimum requirements for a landfill cover which consists of an 18-inch barrier layer constructed of low permeability soil and a six-inch layer of suitable topsoil. Alternative cover designs are provided for in Part (1)(b) of the regulations. The

evaluation of an alternative cover design was completed due to the absence of local borrow sources for material which would be suitable for constructing the barrier layer.

Acceptable alternative cover designs must provide suitable cover material and vegetation to minimize percolation into the landfill. Infiltration rates must be equal to, or less than, infiltration rates resulting from a cover constructed to the minimum requirements described above. We have evaluated several alternative cover systems that rely on a thicker soil layer to retain moisture and an enhanced growth layer which will increase evapotranspiration rates. The alternative designs which were evaluated are depicted on Figure 3 along with the minimum requirement cover system.

Computer modeling of infiltration rates for the minimum requirement case and several alternatives was completed using the Hydrogeologic Evaluation and Landfill Performance Model (HELP) model, version 3.05a. Output for the models are contained in Appendix B. Specific parameters which were critical to the modeling are discussed below.

> Soil Types: Default soil types provided by the HELP model were typically used in the analysis. Topsoil was selected as a sandy loam (Texture No. 6) or loamy sand (Texture No. 4). The barrier layer (low permeable layer) was selected as a compacted silty loam (Texture No. 23) which has a permeability of 9x10E-6 cm/sec, slightly lower than the minimum requirement of 1x10E-5 cm/sec. The refuse layer was selected as municipal waste (Texture No. 18).
>
> Depth of Evapotranspiration: The selected depth of evapotranspiration for the modeling completed is a significant variable effecting the amount of vertical percolation. For modeling the minimum requirement cover, we designated the low permeable layer as a vertical percolation layer so that effects of evapotranspiration in the layer, as well as the overlying topsoil, could be evaluated. Should the low permeable layer have been designated as a barrier layer, the depth of evapotranspiration would have been limited to the six-inch depth of topsoil and trial runs showed that vertical percolation increased up to an order of magnitude. An initial run was performed for the condition where the evapotranspiration depth extends to 24 inches (the total thickness of the topsoil and low permeable layer). A subsequent run was performed for the condition where the evapotranspiration depth extends to a depth of only 12 inches, which may be the case if plant roots are only able to penetrate six-inches or less into the low permeable layer because the layer

would be well compacted and the material may not be well suited to support vegetation.

Depth of evapotranspiration in the alternative covers was selected as 24 inches since the cover materials would be loam-type soils which are loosely placed. Roots should not be impeded from penetrating the full thickness of the cover soil.

Leaf Area Index: A leaf area index of 1.7 was used for all of the cover systems. A leaf area index of 1 is used for a poor stand of vegetation and a leaf area index of 2 is used for a fair stand of vegetation.

Slope: A 5 percent slope was used in the analysis. Although the average slope at the Big Timber landfill is in the range of 25 percent, a 5 percent slope was selected to be conservative. Varying the slope is not expected to yield significantly different results since the barrier layer of the minimum requirement cover is sufficiently permeable that most water reaching it will infiltrate.

Initial Soil Water Content: The initial soil and refuse water contents were set at the field capacity for each unit. Field capacity refers to the maximum amount of water the material can hold before vertical drainage begins to occur. By performing the modeling in this manner, the model more efficiently calculates the average long term percolation rate through the landfill. Alternatively, the initial moisture content of the refuse could have been selected at some value between the wilting point and the field capacity. This would have resulted in most percolation through the cover for several years being added to the moisture content of the refuse until the field capacity of the refuse is attained, at which point drainage of water from the base of the refuse begins to occur.

The models were run using evapotranspiration, precipitation, climatological and solar radiation data which was synthesized by the HELP program for Billings, Montana. The latitude of Big Timber was substituted for the latitude of Billings prior to synthesizing the data to more closely approximate site conditions. A 20 foot thickness of refuse was used in the model based on information provided by the City. Since the initial moisture content of the refuse was set at the field capacity, the thickness of garbage does not substantially affect the results.

Table 1 (Appendix A) summarizes the HELP model output and the results are discussed below.

Minimum Requirement Cover: Average percolation rates through the cover were 0.11 inches per year when an evapotranspiration depth of 24 inches was used, and 0.75 inches per year when an evapotranspiration depth of 12 inches per year was used. The output files show that for an average annual precipitation rate of 15.3 inches per year, only 0.353 inches is shed annually from the cover as runoff while most of the water is removed by the cover through evapotranspiration or percolates into the landfill.

Alternative Covers: As shown in Table 1, the average percolation rate through the Alternative No. 1 cover (sandy loam) is 0.22 inches per year which is slightly higher than the best case percolation rate through the minimum requirement cover (0.11 inches per year). The percolation rates for the two cover designs indicate that evapotranspiration is an effective means for reducing percolation into the landfill. While the percolation rate through the Alternative No. 1 cover is slightly higher than the minimum requirement cover, the alternative cover should provide a better long term cap since it will not be as affected by conditions such as freeze-thaw, desiccation and subsidence. These conditions tend to produce cracks in low permeable barrier layers constructed of soil; percolate water should preferentially flow into and down these cracks which then reduces the effectiveness of evapotranspiration in removing the water prior to infiltration into the underlying refuse.

Additional modeling was completed (Alternatives No. 2 and 3) to further define what soil type would be needed in an alternative cover to yield infiltration rates approximately equal to that of a minimum requirement cover. Results in Table 1 indicate that a loamy sand or other soils coarser than a sandy loam should not be used in the cover since they do not appear to provide sufficient moisture holding capacity.

3.2 CONSTRUCTION OF LANDFILL CLOSURE

Features and proposed work for the landfill closure are shown on Sheets 1, 2 and 3 (Exhibits). Closure of the landfill unit will include construction of the cover system over that portion of the unit containing municipal waste, an area of approximately 1.2 acres. The limit of solid waste placement is shown on Sheet 2. The former burn pit area will not be reclaimed because a license for use of this area as a Class IV landfill may be requested by

the City in the future. The detention pond will not be reclaimed because: 1) the pond has never contained water; and, 2) the City may wish to develop the property for other future uses which may need a detention pond for stormwater control. To reduce water flow into the pond, the culvert on the northeast corner of the pond (Sheet 1) will be plugged.

Construction of the landfill cover system will include the following steps.

1. Provide imported borrow to reduce slopes which are steeper than 3:1. This step has been completed by the City.

2. Place and spread suitable cover material over the landfill unit to a depth of 18 inches. Depth of placement should be monitored using grade stakes. Estimated volume required is 4,500 cubic yards. Suitable material includes:

   - Stockpiled material on the south end of the landfill unit (sandy clay loam, 800 cubic yards, see Appendix C for sieve, pH and EC results)

   - Stockpiled material on the east side of the burn pit (sandy clay loam - 900 cubic yards)

   - On-site borrow obtained from area immediately southwest of landfill (sandy loam - 3,700 cubic yards, see Appendix C for sieve, pH and EC results). The volume of borrow material at this location may be less than estimated. Additional test pits should be completed to verify the volume available. To develop the borrow area, the uppermost six inches of soil should be salvaged and replaced following excavation of the borrow material.

   - Additional borrow (sandy loam or finer textured soil). The additional borrow may come from on-site sources, which can be identified, or from off-site sources.

   Placement should be completed in two lifts using a dozer for spreading the material so that it is not overly compacted. The sandy clay loam exhibits a slightly elevated electrical conductivity (EC=5.4) and should therefore be placed in the first lift to better promote revegetation. Each lift should be thoroughly tracked by the dozer.

3. Place and spread suitable seed bed material (topsoil) to a depth of six inches. Suitable seedbed material must be capable of sustaining native plant growth. Depth of placement should be monitored using grade stakes. Estimated volume required is 1,500 cubic yards. Suitable material includes:

   - Stockpiled topsoil material in northern portion of landfill unit (1050 cubic yards). This material should be placed on west, south and north slopes where grass development is most critical for limiting wind erosion. Place remaining material available on east slopes.

   - Additional seed bed borrow material (450 cubic yards). Sources of additional seedbed material include the sandy loam borrow located immediately southwest of the landfill cell, other on-site sources which have not yet been identified, and off-site borrow material.

4. Complete fine grading of the seedbed layer.

5. Revegetate surface using a seed mix and methods provided by the local Natural Resource and Conservation Service office (Appendix D). Planting should be completed as soon as possible after construction of the cover. The site should be periodically monitored for wind erosion, and if severe enough, mitigation measures (e.g. application of hydromulch) may need to be employed.

3.3 DEED REQUIREMENTS

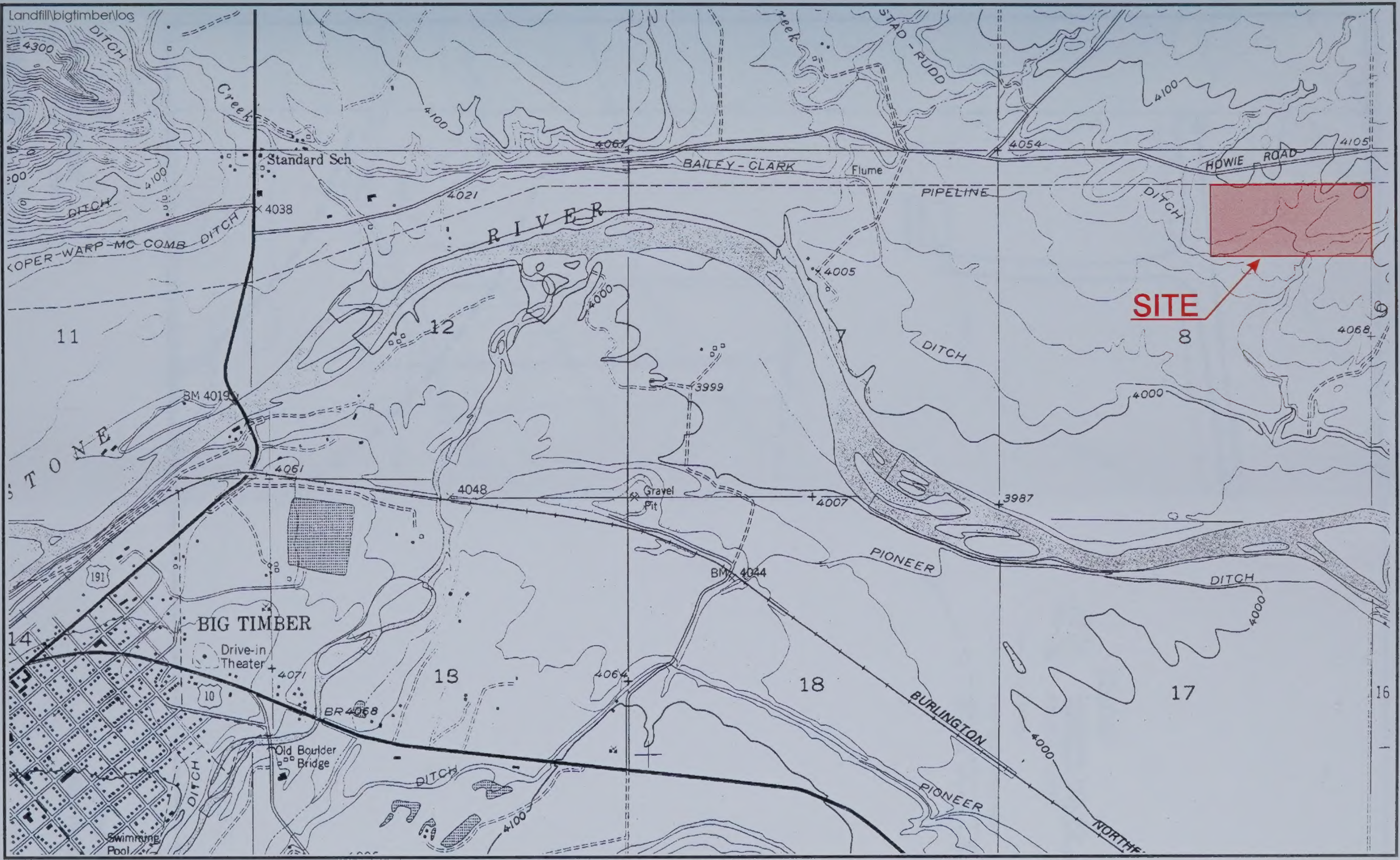
The City must provide a notation on the deed for the landfill property in accordance with requirements of ARM 17.50.530.

APPENDIX A

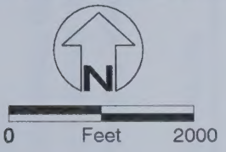
FIGURES AND TABLES

APPENDIX A

FIGURES AND TABLES

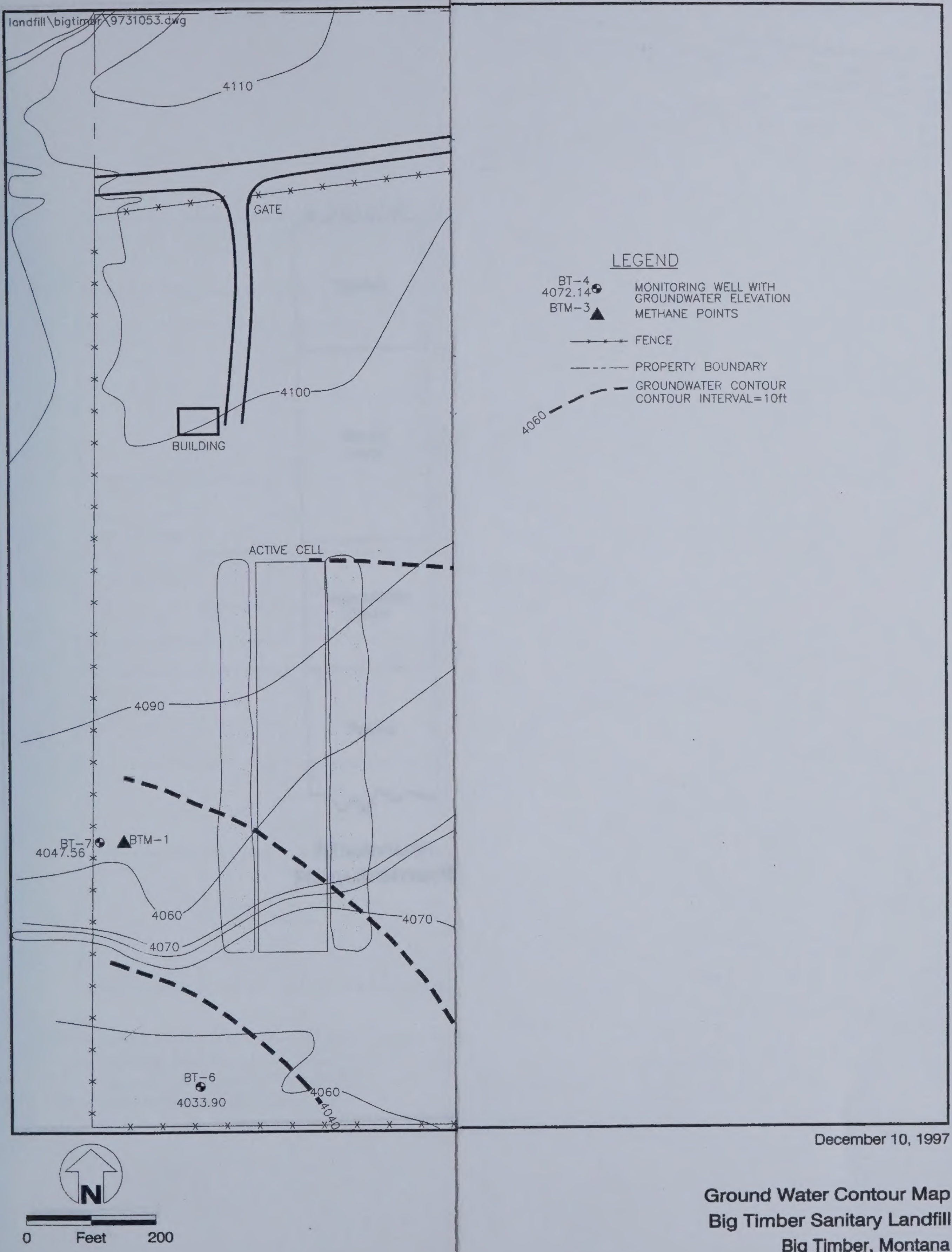

Landfill\bigtimber\loc
SITE
HOWIE ROAD
BAILEY - CLARK
PIPELINE
RIVER
Standard Sch
BIG TIMBER
Drive-in Theater
Gravel Pit
Old Boulder Bridge
Swimming Pool
BURLINGTON
NORTHE
PIONEER
DITCH
Flume
Creek
STONE
11
12
13
14
7
8
9
16
17
18

From USGS 7.5' Big Timber Quad


N
0
Feet
2000

MAXIM 9731053.200

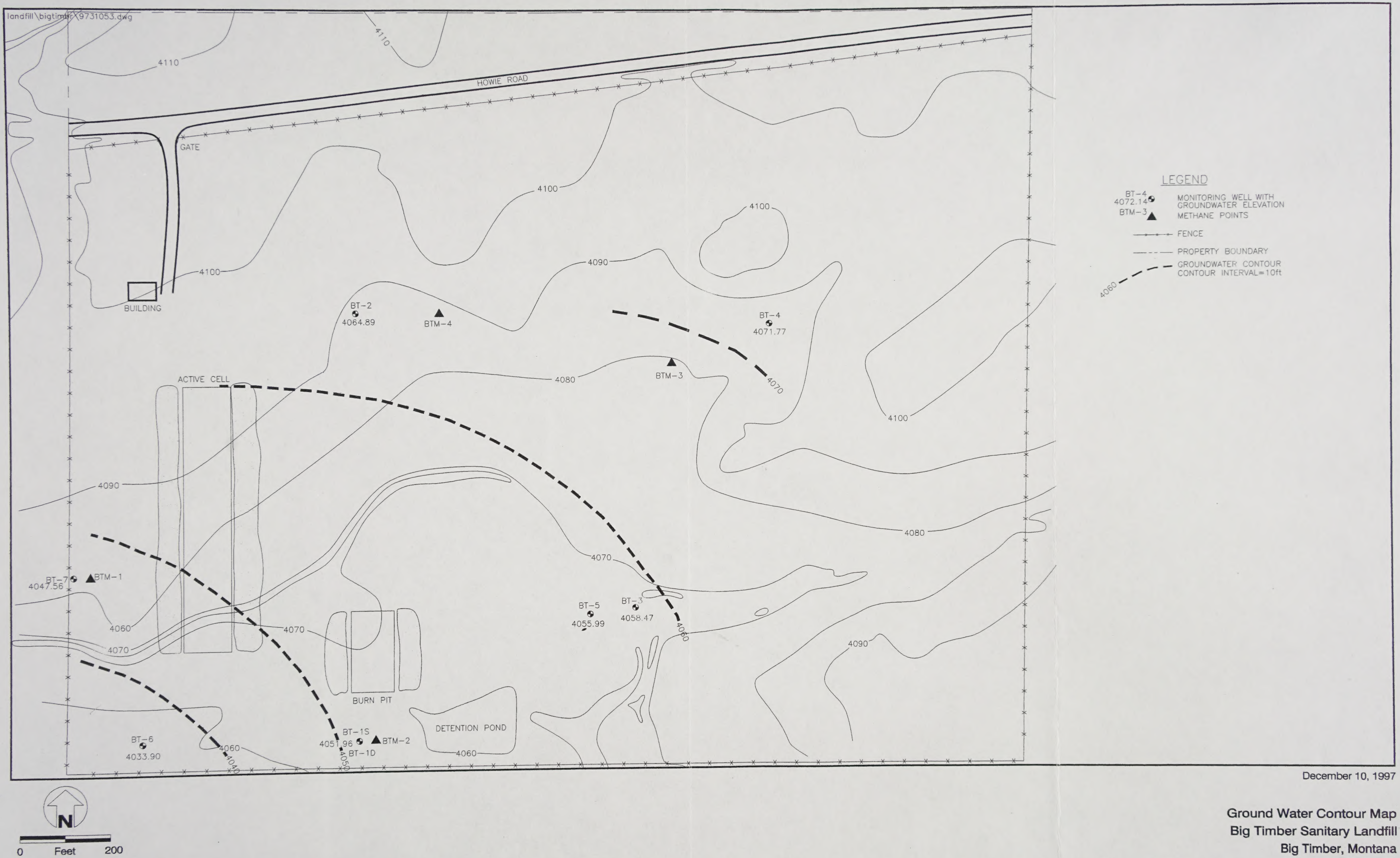
Location Map
City of Big Timber Sanitary Landfill
Sweet Grass County, Montana
FIGURE 1


landfill\bigtimber\9731053.dwg
4110
GATE
4100
BUILDING
ACTIVE CELL
4090
BT-7
4047.56
BTM-1
4060
4070
4070
4060
BT-6
4033.90
4060
4040
LEGEND
BT-4
4072.14
MONITORING WELL WITH GROUNDWATER ELEVATION
BTM-3
METHANE POINTS
FENCE
PROPERTY BOUNDARY
4060
GROUNDWATER CONTOUR
CONTOUR INTERVAL=10ft
N
0
Feet
200

December 10, 1997

Ground Water Contour Map
Big Timber Sanitary Landfill
Big Timber, Montana
FIGURE 2

MAXIM 9731053.200

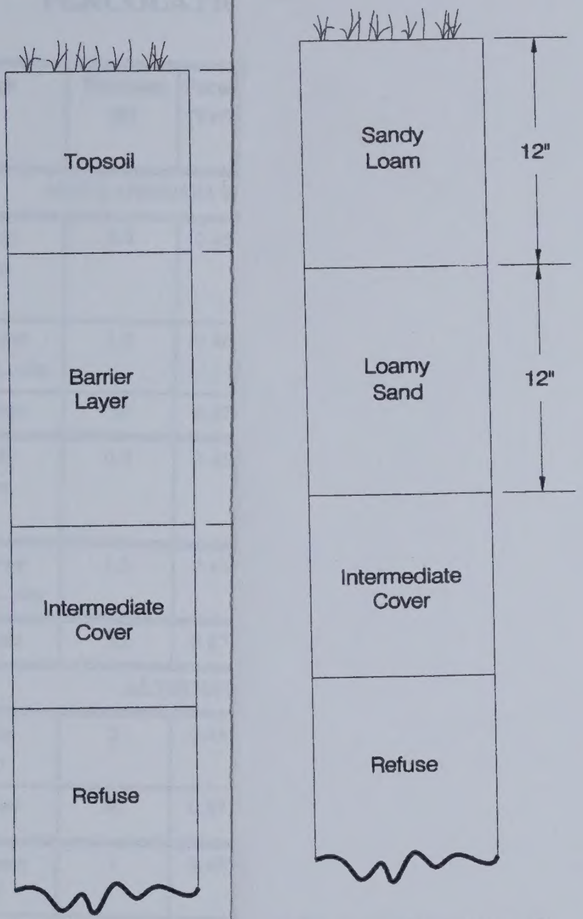

landfill\bigtimbr\9731053.dwg
HOWIE ROAD
GATE
BUILDING
4110
4100
4090
4080
4070
4060
4050
4040
BT-2
4064.89
BTM-4
BT-4
4071.77
BTM-3
ACTIVE CELL
BT-7
4047.56
BTM-1
BT-5
4055.99
BT-3
4058.47
BURN PIT
DETENTION POND
BT-1S
4051.96
BT-1D
BTM-2
BT-6
4033.90
LEGEND
BT-4
4072.14
MONITORING WELL WITH GROUNDWATER ELEVATION
BTM-3
METHANE POINTS
FENCE
PROPERTY BOUNDARY
4060
GROUNDWATER CONTOUR
CONTOUR INTERVAL=10ft
N
0
Feet
200

December 10, 1997

Ground Water Contour Map
Big Timber Sanitary Landfill
Big Timber, Montana
FIGURE 2

MAXIM 9731053.200

landfill\bigtimbr\cover.dwg


Topsoil
Barrier Layer
Intermediate Cover
Refuse
Sandy Loam
12"
Loamy Sand
12"
Intermediate Cover
Refuse

Minimum Requirement

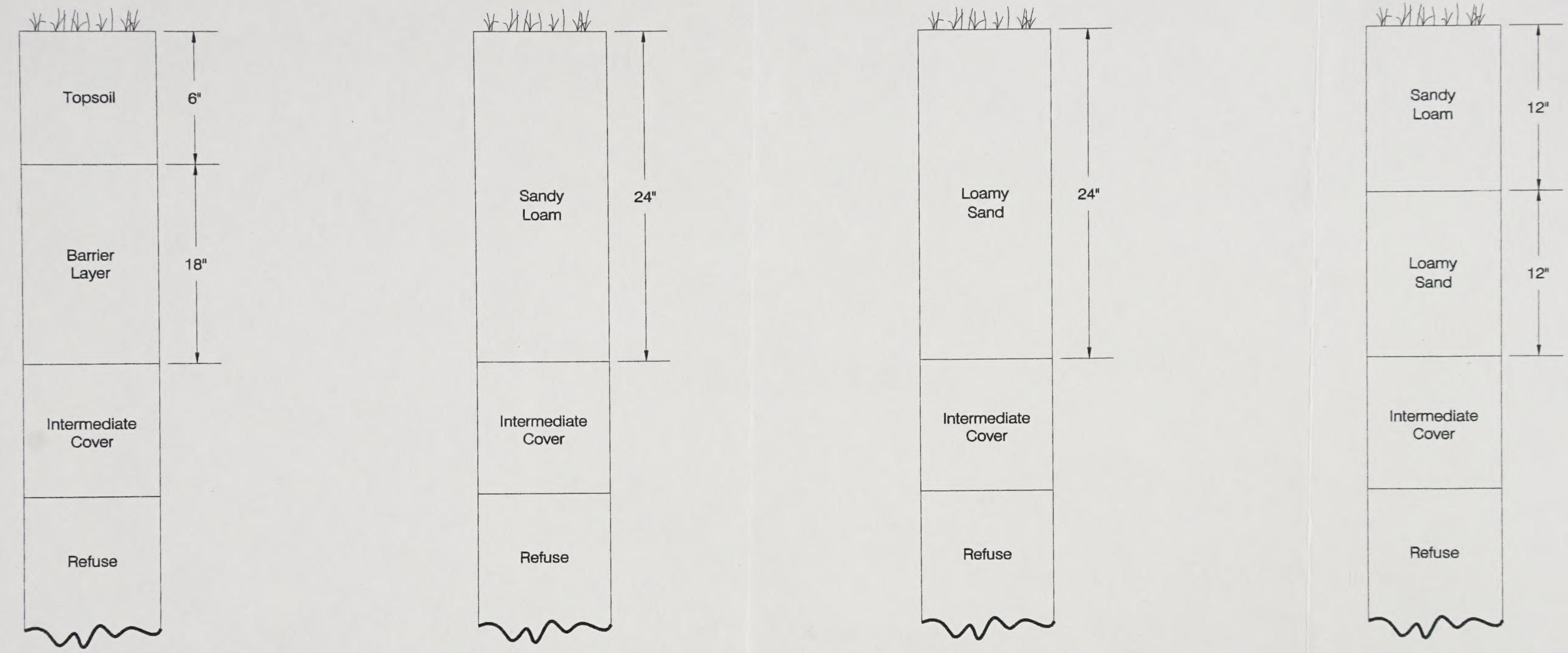
Alternative No.3

N.T.S.

MAXIM 9731053.200

Landfill Cover Designs
Big Timber Sanitary Landfill
Big Timber, Montana
FIGURE 3

landfill\bigtimbr\cover.dwg


Topsoil
6"
Barrier Layer
18"
Intermediate Cover
Refuse
Sandy Loam
24"
Intermediate Cover
Refuse
Loamy Sand
24"
Intermediate Cover
Refuse
Sandy Loam
12"
Loamy Sand
12"
Intermediate Cover
Refuse

Minimum Requirement

Alternative No.1

Alternative No.2

Alternative No.3

N.T.S.

MAXIM 9731053.200

Landfill Cover Designs
Big Timber Sanitary Landfill
Big Timber, Montana
FIGURE 3

TABLE 1
PERCOLATION ESTIMATES

Description	Layer No.	Type	Thickness (ft)	Porosity (Vv/Vs)	Field Capacity (Vw/Vs)	k (cm/sec)	CN	ET Depth (in)	Average Percolation Rate (in/year, with 95% standard deviation)
MDEQ MINIMUM REQUIREMENT COVER									
MDEQ Min Req (evapotranspiration depth 24 inches)	1	sandy loam	0.5	0.453	0.190	7.2e-04	62.9	24	0.11 +/- 0.32
	2	Barrier Soil, clay	1.5	0.461	0.360	9.0e-6			
	3	Refuse	50	0.671	0.292	1.0e-3			
MDEQ Min Req (evapotranspiration depth 12 inches)	1	sandy loam	0.5	0.453	0.190	7.2e-04	62.9	12	0.75 +/- 0.76
	2	Barrier Soil, clay	1.5	0.461	0.360	9.0e-6			
	3	Refuse	50	0.671	0.292	1.0e-3			
ALTERNATIVE COVERS									
Alternative No. 1	1	sandy loam	2	0.453	0.190	7.2e-04	62.9	24	0.22 +/- 0.50
	2	Refuse	50	0.671	0.292	1.0e-3			
Alternative No. 2	1	Loamy sand	2	0.437	0.190	1.7e-3	52.6	24	1.32 +/- 0.83
	2	Refuse	50	0.671	0.292	1.0e-3			
Alternative No. 3	1	sandy loam	1	0.453	0.190	7.2e-04	62.9	24	0.91 +/- 0.70
	2	Loamy sand	1	0.437	0.190	1.7e-3			
	3	Refuse	50	0.671	0.292	1.0e-3			

notes

Vv = Volume of voids, Vs = volume of soil, Vw = volume of water
k = permeability, in centimeters per second (cm/sec)
CN = Curve number, an indicator of runoff potential
ET = Evapotranspiration depth, in inches (in)

APPENDIX B

MODELING RESULTS FOR LANDFILL COVER PERCOLATION RATES

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.05a  (5 JUNE 1996)                  **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     a:\BIGT1.D4
TEMPERATURE DATA FILE:       a:\BIGT1.D7
SOLAR RADIATION DATA FILE:   a:\BIGT1.D13
EVAPOTRANSPIRATION DATA:     a:\bigt1.D11
SOIL AND DESIGN DATA FILE:   a:\bigt1.D10
OUTPUT DATA FILE:            a:\bigt1.OUT


TIME:  13:46     DATE:   4/13/1998


******************************************************************************
```

ET = 12 inches

```
     TITLE:  Big Timber Landfill, MDEQ Minimum Requirements

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
            WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4530 VOL/VOL
          FIELD CAPACITY                =      0.1900 VOL/VOL
          WILTING POINT                 =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =   0.720000011000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.61
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------
```

```
               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  23
     THICKNESS                    =   18.00   INCHES
     POROSITY                     =     0.4610 VOL/VOL
     FIELD CAPACITY               =     0.3600 VOL/VOL
     WILTING POINT                =     0.2030 VOL/VOL
     INITIAL SOIL WATER CONTENT   =     0.3600 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.900000032000E-05 CM/SEC


                           LAYER  3
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  18
     THICKNESS                    =  240.00   INCHES
     POROSITY                     =     0.6710 VOL/VOL
     FIELD CAPACITY               =     0.2920 VOL/VOL
     WILTING POINT                =     0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT   =     0.2920 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
            GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
            AND A SLOPE LENGTH OF  200. FEET.

   SCS RUNOFF CURVE NUMBER              =     62.90
   FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =     20.000  ACRES
   EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =      3.300  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =      5.484  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.728  INCHES
   INITIAL SNOW WATER                   =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS     =     77.700  INCHES
   TOTAL INITIAL WATER                  =     77.700  INCHES
   TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


              EVAPOTRANSPIRATION AND WEATHER DATA
              -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
            BILLINGS             MONTANA

       STATION LATITUDE                          =  45.48 DEGREES
       MAXIMUM LEAF AREA INDEX                   =   1.70
       START OF GROWING SEASON (JULIAN DATE)     =   130
       END OF GROWING SEASON (JULIAN DATE)       =   278
       EVAPORATIVE ZONE DEPTH                    =  12.0  INCHES
       AVERAGE ANNUAL WIND SPEED                 =  11.30 MPH
       AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  59.00 %
```

```
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  54.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  47.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  58.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BILLINGS              MONTANA

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
    -------      -------      -------      -------      -------      -------
      0.97         0.71         1.05         1.93         2.39         2.07
      0.85         1.05         1.26         1.16         0.85         0.80


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BILLINGS              MONTANA

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
    -------      -------      -------      -------      -------      -------
     20.90        28.40        33.80        44.60        54.90        64.00
     72.30        70.30        59.40        49.30        35.00        27.10


      NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BILLINGS              MONTANA
                AND STATION LATITUDE  =  45.48 DEGREES



*******************************************************************************

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  0.97     0.71     0.94     1.95     2.50     2.05
                           0.98     1.08     1.15     1.25     0.88     0.85

   STD. DEVIATIONS         0.51     0.38     0.48     1.02     1.22     0.92
                           0.51     0.66     0.78     0.66     0.62     0.55

 RUNOFF
 ------
   TOTALS                  0.008    0.055    0.112    0.164    0.000    0.000
                           0.000    0.000    0.000    0.000    0.002    0.013

   STD. DEVIATIONS         0.034    0.124    0.176    0.349    0.003    0.000
                           0.000    0.000    0.000    0.000    0.010    0.056

 EVAPOTRANSPIRATION
 ------------------
```

```
    TOTALS                       0.674     0.505     0.715     2.029     2.411     2.379
                                 1.183     0.841     1.315     0.860     0.727     0.571

    STD. DEVIATIONS              0.263     0.223     0.401     0.838     1.028     1.018
                                 0.634     0.613     0.757     0.545     0.330     0.270

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS                      0.0032    0.0000    0.0209    0.2442    0.3157    0.1125
                                0.0087    0.0000    0.0002    0.0017    0.0162    0.0222

    STD. DEVIATIONS             0.0297    0.0000    0.0858    0.3153    0.4800    0.3356
                                0.0627    0.0000    0.0024    0.0166    0.0719    0.0970

*******************************************************************************

*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                       INCHES             CU. FEET      PERCENT
                                 -------------------  -------------  ---------
 PRECIPITATION                    15.31    (   2.793)   1111542.9     100.00

 RUNOFF                            0.353   (  0.4717)     25624.63      2.305

 EVAPOTRANSPIRATION               14.209   (  2.3989)   1031591.62     92.807

 PERCOLATION/LEAKAGE THROUGH       0.74561 (  0.76404)    54130.992     4.86990
   LAYER  3

 CHANGE IN WATER STORAGE           0.003   (  0.8937)       194.97      0.018

*******************************************************************************
```

```
*****************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
   ------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------   -------------
        PRECIPITATION                              2.77        201102.000

        RUNOFF                                     0.886        64313.6211

        PERCOLATION/LEAKAGE THROUGH LAYER  3       0.162706     11812.45410

        SNOW WATER                                 2.93        212376.1090


        MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4292

        MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1440

*****************************************************************************
```

```
******************************************************************************

              FINAL WATER STORAGE AT END OF YEAR  100
      ----------------------------------------------------------------------
              LAYER        (INCHES)        (VOL/VOL)
              -----        --------        ---------
                1           1.6040          0.2673

                2           5.9088          0.3283

                3          70.0553          0.2919

             SNOW WATER     0.400

******************************************************************************
******************************************************************************
```

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.05a  (5 JUNE 1996)                     **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      a:\BIGT1.D4
TEMPERATURE DATA FILE:        a:\BIGT1.D7
SOLAR RADIATION DATA FILE:    a:\BIGT1.D13
EVAPOTRANSPIRATION DATA:      a:\bigt2.D11
SOIL AND DESIGN DATA FILE:    a:\bigt1.D10
OUTPUT DATA FILE:             a:\bigt1-24.OUT


TIME:  13:49      DATE:   4/13/1998


******************************************************************************
```

ET=24"

```
     TITLE:  Big Timber Landfill, MDEQ Minimum Requirements

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                 LAYER  1
                                 --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4530 VOL/VOL
          FIELD CAPACITY             =      0.1900 VOL/VOL
          WILTING POINT              =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.61
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------
```

```
                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  23
       THICKNESS                    =     18.00    INCHES
       POROSITY                     =      0.4610 VOL/VOL
       FIELD CAPACITY               =      0.3600 VOL/VOL
       WILTING POINT                =      0.2030 VOL/VOL
       INITIAL SOIL WATER CONTENT   =      0.3600 VOL/VOL
       EFFECTIVE SAT. HYD. COND.    =   0.900000032000E-05 CM/SEC


                              LAYER  3
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
       THICKNESS                    =    240.00    INCHES
       POROSITY                     =      0.6710 VOL/VOL
       FIELD CAPACITY               =      0.2920 VOL/VOL
       WILTING POINT                =      0.0770 VOL/VOL
       INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
       EFFECTIVE SAT. HYD. COND.    =   0.100000005000E-02 CM/SEC


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
              GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
              AND A SLOPE LENGTH OF  200. FEET.

    SCS RUNOFF CURVE NUMBER               =     62.90
    FRACTION OF AREA ALLOWING RUNOFF      =    100.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE    =     20.000  ACRES
    EVAPORATIVE ZONE DEPTH                =     24.0    INCHES
    INITIAL WATER IN EVAPORATIVE ZONE     =      7.620  INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE    =     11.016  INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE    =      4.164  INCHES
    INITIAL SNOW WATER                    =      0.000  INCHES
    INITIAL WATER IN LAYER MATERIALS      =     77.700  INCHES
    TOTAL INITIAL WATER                   =     77.700  INCHES
    TOTAL SUBSURFACE INFLOW               =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

     NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
              BILLINGS                MONTANA

         STATION LATITUDE                           =  45.48 DEGREES
         MAXIMUM LEAF AREA INDEX                    =   1.70
         START OF GROWING SEASON (JULIAN DATE)      =  130
         END OF GROWING SEASON (JULIAN DATE)        =  278
         EVAPORATIVE ZONE DEPTH                     =  24.0  INCHES
         AVERAGE ANNUAL WIND SPEED                  =  11.30 MPH
         AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  59.00 %
```

```
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  54.00 %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  47.00 %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  58.00 %


       NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR     BILLINGS            MONTANA

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
    -------      -------      -------      -------      -------      -------
      0.97         0.71         1.05         1.93         2.39         2.07
      0.85         1.05         1.26         1.16         0.85         0.80


       NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR     BILLINGS            MONTANA

           NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
    -------      -------      -------      -------      -------      -------
     20.90        28.40        33.80        44.60        54.90        64.00
     72.30        70.30        59.40        49.30        35.00        27.10


       NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR     BILLINGS            MONTANA
                  AND STATION LATITUDE  =   45.48 DEGREES



*******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS     1 THROUGH  100
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.97     0.71     0.94     1.95     2.50     2.05
                           0.98     1.08     1.15     1.25     0.88     0.85

    STD. DEVIATIONS        0.51     0.38     0.48     1.02     1.22     0.92
                           0.51     0.66     0.78     0.66     0.62     0.55

  RUNOFF
  ------
    TOTALS                 0.006    0.032    0.056    0.087    0.000    0.000
                           0.000    0.000    0.000    0.000    0.001    0.010

    STD. DEVIATIONS        0.023    0.089    0.106    0.220    0.000    0.000
                           0.000    0.000    0.000    0.000    0.008    0.050

  EVAPOTRANSPIRATION
  ------------------
```

```
   TOTALS                      0.674     0.512     0.711     2.046     2.634     2.526
                               1.574     1.028     1.110     0.943     0.693     0.564

   STD. DEVIATIONS             0.263     0.218     0.361     0.752     0.946     1.033
                               0.875     0.644     0.693     0.447     0.242     0.256

 PERCOLATION/LEAKAGE THROUGH LAYER  3
 ------------------------------------
   TOTALS                     0.0000    0.0000    0.0000    0.0221    0.0649    0.0247
                              0.0032    0.0002    0.0000    0.0000    0.0000    0.0000

   STD. DEVIATIONS            0.0000    0.0000    0.0000    0.1151    0.2106    0.1306
                              0.0139    0.0024    0.0000    0.0000    0.0000    0.0000

*******************************************************************************

*******************************************************************************

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                           INCHES           CU. FEET      PERCENT
                                     -------------------  -------------  ---------
  PRECIPITATION                        15.31    (   2.793)   1111542.9     100.00

  RUNOFF                                0.192   (  0.2904)     13973.47      1.257

  EVAPOTRANSPIRATION                   15.014   (  2.6613)   1090037.12     98.065

  PERCOLATION/LEAKAGE THROUGH           0.11506 (  0.32173)     8353.303     0.75151
    LAYER  3

  CHANGE IN WATER STORAGE              -0.011   (  1.1362)      -821.45     -0.074

*******************************************************************************
```

```
******************************************************************************

          PEAK DAILY VALUES FOR YEARS     1 THROUGH  100
------------------------------------------------------------------------
                                           (INCHES)      (CU. FT.)
                                          ----------    -------------
     PRECIPITATION                           2.77        201102.000

     RUNOFF                                  0.728        52861.1523

     PERCOLATION/LEAKAGE THROUGH LAYER  3    0.141906     10302.37400

     SNOW WATER                              2.93        212376.1090

     MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.3759

     MINIMUM VEG. SOIL WATER (VOL/VOL)              0.1735

******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR  100
       ----------------------------------------------------------------
                LAYER       (INCHES)        (VOL/VOL)
                -----       --------        ---------
                  1           1.9471           0.3245

                  2           4.1611           0.2312

                  3          70.0598           0.2919

               SNOW WATER     0.400

******************************************************************************
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```

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.05a  (5 JUNE 1996)                   **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      n:\bigtimbe\BIGT1.D4
TEMPERATURE DATA FILE:        n:\bigtimbe\bigt1.D7
SOLAR RADIATION DATA FILE:    n:\bigtimbe\bigt1.D13
EVAPOTRANSPIRATION DATA:      N:\bigtimbe\bigt2.D11
SOIL AND DESIGN DATA FILE:    n:\bigtimbe\bigt2.D10
OUTPUT DATA FILE:             n:\bigtimbe\bigt2.OUT


TIME:  15: 3     DATE:   2/10/1998


******************************************************************************

    TITLE:  Big Timber Landfill, Cover Alternative   Sandy loam, Alt 1

******************************************************************************


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
             WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
          THICKNESS                     =     24.00    INCHES
          POROSITY                      =      0.4530 VOL/VOL
          FIELD CAPACITY                =      0.1900 VOL/VOL
          WILTING POINT                 =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.61
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER  2
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =    600.00    INCHES
          POROSITY                      =      0.6710 VOL/VOL
          FIELD CAPACITY                =      0.2920 VOL/VOL
          WILTING POINT                 =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2920 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                    GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                    ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
```

```
              SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
              GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
              AND A SLOPE LENGTH OF  200. FEET.

         SCS RUNOFF CURVE NUMBER                  =      62.90
         FRACTION OF AREA ALLOWING RUNOFF         =     100.0    PERCENT
         AREA PROJECTED ON HORIZONTAL PLANE       =      20.000  ACRES
         EVAPORATIVE ZONE DEPTH                   =      24.0    INCHES
         INITIAL WATER IN EVAPORATIVE ZONE        =       4.560  INCHES
         UPPER LIMIT OF EVAPORATIVE STORAGE       =      10.872  INCHES
         LOWER LIMIT OF EVAPORATIVE STORAGE       =       2.040  INCHES
         INITIAL SNOW WATER                       =       0.000  INCHES
         INITIAL WATER IN LAYER MATERIALS         =     179.760  INCHES
         TOTAL INITIAL WATER                      =     179.760  INCHES
         TOTAL SUBSURFACE INFLOW                  =       0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

          NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
              BILLINGS            MONTANA

            STATION LATITUDE                             =  45.48 DEGREES
            MAXIMUM LEAF AREA INDEX                      =   1.70
            START OF GROWING SEASON (JULIAN DATE)        =   130
            END OF GROWING SEASON (JULIAN DATE)          =   278
            EVAPORATIVE ZONE DEPTH                       =  24.0  INCHES
            AVERAGE ANNUAL WIND SPEED                    =  11.30 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY        =  59.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY        =  54.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY        =  47.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY        =  58.00 %


          NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BILLINGS             MONTANA

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        0.97        0.71        1.05        1.93        2.39        2.07
        0.85        1.05        1.26        1.16        0.85        0.80


          NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BILLINGS             MONTANA

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       20.90       28.40       33.80       44.60       54.90       64.00
       72.30       70.30       59.40       49.30       35.00       27.10


          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BILLINGS             MONTANA
                AND STATION LATITUDE  =  45.48 DEGREES



*******************************************************************************

          AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  0.97     0.71     0.94     1.95     2.50     2.05
```

```
                          0.98      1.08      1.15      1.25      0.88      0.85

    STD. DEVIATIONS       0.51      0.38      0.48      1.02      1.22      0.92
                          0.51      0.66      0.78      0.66      0.62      0.55

  RUNOFF
  ------
    TOTALS                0.005     0.031     0.054     0.081     0.000     0.000
                          0.000     0.000     0.000     0.000     0.001     0.009

    STD. DEVIATIONS       0.022     0.086     0.103     0.197     0.000     0.000
                          0.000     0.000     0.000     0.000     0.008     0.049

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                0.673     0.509     0.724     2.070     2.541     2.502
                          1.432     1.036     1.113     0.995     0.741     0.576

    STD. DEVIATIONS       0.264     0.219     0.384     0.795     0.970     1.055
                          0.740     0.647     0.700     0.489     0.273     0.273

  PERCOLATION/LEAKAGE THROUGH LAYER  2
  ------------------------------------
    TOTALS                0.0002    0.0000    0.0000    0.0407    0.1259    0.0526
                          0.0037    0.0000    0.0000    0.0000    0.0000    0.0000

    STD. DEVIATIONS       0.0024    0.0000    0.0000    0.1283    0.3384    0.1912
                          0.0132    0.0000    0.0000    0.0000    0.0000    0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                      INCHES             CU. FEET       PERCENT
                                -------------------   -------------    ---------
 PRECIPITATION                  15.31     (   2.793)   1111542.9       100.00

 RUNOFF                          0.182    (  0.2648)     13190.65        1.187

 EVAPOTRANSPIRATION             14.911    (  2.5717)   1082512.50       97.388

 PERCOLATION/LEAKAGE THROUGH     0.22315  (  0.49595)    16200.472       1.45748
   LAYER  2

 CHANGE IN WATER STORAGE        -0.005    (  1.0353)      -361.08       -0.032

*******************************************************************************
```

```
*******************************************************************************

          PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
----------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
   PRECIPITATION                                2.77        201102.000

   RUNOFF                                       0.655        47562.9180

   PERCOLATION/LEAKAGE THROUGH LAYER  2         0.131623      9555.80273

   SNOW WATER                                   2.93        212376.1090

   MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.2845

   MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0850

*******************************************************************************
```

```
******************************************************************************

              FINAL WATER STORAGE AT END OF YEAR  100
      ----------------------------------------------------------------------
                LAYER        (INCHES)      (VOL/VOL)
                -----        --------      ---------
                  1            3.6752        0.1531

                  2          175.1870        0.2920

               SNOW WATER      0.400

******************************************************************************
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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                  **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     n:\bigtimbe\BIGT1.D4
TEMPERATURE DATA FILE:       n:\bigtimbe\bigt1.D7
SOLAR RADIATION DATA FILE:   n:\bigtimbe\bigt1.D13
EVAPOTRANSPIRATION DATA:     N:\bigtimbe\bigt2.D11
SOIL AND DESIGN DATA FILE:   n:\bigtimbe\bigt3.D10
OUTPUT DATA FILE:            n:\bigtimbe\bigt3.OUT


TIME:  14:38     DATE:   2/10/1998


******************************************************************************

     TITLE:  Big Timber Landfill, Cover Alternative        Loamy Sand, ALT 2

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                    LAYER  1
                                    --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   4
          THICKNESS                     =     24.00    INCHES
          POROSITY                      =      0.4370 VOL/VOL
          FIELD CAPACITY                =      0.1050 VOL/VOL
          WILTING POINT                 =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.170000002000E-02 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.61
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                    LAYER  2
                                    --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =    600.00    INCHES
          POROSITY                      =      0.6710 VOL/VOL
          FIELD CAPACITY                =      0.2920 VOL/VOL
          WILTING POINT                 =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2920 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                    GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                    ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
```

```
               SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A
               GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
               AND A SLOPE LENGTH OF  200. FEET.

          SCS RUNOFF CURVE NUMBER                 =     52.60
          FRACTION OF AREA ALLOWING RUNOFF        =    100.0    PERCENT
          AREA PROJECTED ON HORIZONTAL PLANE      =     20.000  ACRES
          EVAPORATIVE ZONE DEPTH                  =     24.0    INCHES
          INITIAL WATER IN EVAPORATIVE ZONE       =      4.560  INCHES
          UPPER LIMIT OF EVAPORATIVE STORAGE      =     10.488  INCHES
          LOWER LIMIT OF EVAPORATIVE STORAGE      =      1.128  INCHES
          INITIAL SNOW WATER                      =      0.000  INCHES
          INITIAL WATER IN LAYER MATERIALS        =    179.760  INCHES
          TOTAL INITIAL WATER                     =    179.760  INCHES
          TOTAL SUBSURFACE INFLOW                 =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

           NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                    BILLINGS              MONTANA

              STATION LATITUDE                             =  45.48 DEGREES
              MAXIMUM LEAF AREA INDEX                      =   1.70
              START OF GROWING SEASON (JULIAN DATE)        =  130
              END OF GROWING SEASON (JULIAN DATE)          =  278
              EVAPORATIVE ZONE DEPTH                       =  24.0  INCHES
              AVERAGE ANNUAL WIND SPEED                    =  11.30 MPH
              AVERAGE 1ST QUARTER RELATIVE HUMIDITY        =  59.00 %
              AVERAGE 2ND QUARTER RELATIVE HUMIDITY        =  54.00 %
              AVERAGE 3RD QUARTER RELATIVE HUMIDITY        =  47.00 %
              AVERAGE 4TH QUARTER RELATIVE HUMIDITY        =  58.00 %


           NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                    COEFFICIENTS FOR    BILLINGS              MONTANA

                    NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

        JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
        -------      -------      -------      -------      -------      -------
         0.97         0.71         1.05         1.93         2.39         2.07
         0.85         1.05         1.26         1.16         0.85         0.80


           NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                    COEFFICIENTS FOR    BILLINGS              MONTANA

              NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

        JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
        -------      -------      -------      -------      -------      -------
         20.90        28.40        33.80        44.60        54.90        64.00
         72.30        70.30        59.40        49.30        35.00        27.10


           NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                    COEFFICIENTS FOR    BILLINGS              MONTANA
                      AND STATION LATITUDE  =  45.48 DEGREES



*******************************************************************************

           AVERAGE MONTHLY VALUES IN INCHES FOR YEARS     1 THROUGH  100
-------------------------------------------------------------------------------

                             JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                             -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                     0.97     0.71     0.94     1.95     2.50     2.05
```

```
                              0.98      1.08      1.15      1.25      0.88      0.85
*******************************************************************************
    STD. DEVIATIONS           0.51      0.38      0.48      1.02      1.22      0.92
                              0.51      0.66      0.78      0.66      0.62      0.55

  RUNOFF
  ------
    TOTALS                    0.007     0.035     0.058     0.083     0.000     0.000
                              0.000     0.000     0.000     0.000     0.001     0.010

    STD. DEVIATIONS           0.026     0.093     0.106     0.200     0.000     0.000
                              0.000     0.000     0.000     0.000     0.009     0.051

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                    0.673     0.517     0.658     1.622     2.224     2.521
                              1.717     0.951     1.063     0.786     0.541     0.527

    STD. DEVIATIONS           0.263     0.215     0.270     0.546     0.707     0.795
                              0.828     0.588     0.667     0.389     0.222     0.252

  PERCOLATION/LEAKAGE THROUGH LAYER  2
  ------------------------------------
    TOTALS                    0.0017    0.0003    0.0321    0.1824    0.3152    0.3192
                              0.1736    0.0579    0.0663    0.0731    0.0732    0.0322

    STD. DEVIATIONS           0.0089    0.0025    0.0822    0.2158    0.3840    0.4234
                              0.1178    0.0307    0.0463    0.0503    0.0796    0.0564

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                       INCHES              CU. FEET      PERCENT
                               -------------------     -------------    ---------
 PRECIPITATION                   15.31     (   2.793)    1111542.9      100.00

 RUNOFF                           0.194    (  0.2747)      14120.18      1.270

 EVAPOTRANSPIRATION              13.800    (  2.2628)    1001881.62     90.134

 PERCOLATION/LEAKAGE THROUGH      1.32715  (  0.83489)     96351.289     8.66825
   LAYER  2

 CHANGE IN WATER STORAGE         -0.011    (  1.1036)       -810.50     -0.073
*******************************************************************************
```

```
******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                            2.77        201102.000

      RUNOFF                                   0.658        47787.0703

      PERCOLATION/LEAKAGE THROUGH LAYER  2     0.139708     10142.79880

      SNOW WATER                               2.93        212376.1090

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.2434

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0470

******************************************************************************
```

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******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR  100
     ----------------------------------------------------------------------

                LAYER        (INCHES)        (VOL/VOL)
                -----        --------        ---------
                  1           3.0731          0.1280

                  2         175.1700          0.2919

               SNOW WATER      0.400

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                  **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     n:\bigtimbe\BIGT1.D4
TEMPERATURE DATA FILE:       n:\bigtimbe\bigt1.D7
SOLAR RADIATION DATA FILE:   n:\bigtimbe\bigt1.D13
EVAPOTRANSPIRATION DATA:     N:\bigtimbe\bigt2.D11
SOIL AND DESIGN DATA FILE:   n:\bigtimbe\BIGT4.D10
OUTPUT DATA FILE:            n:\bigtimbe\bigt4.OUT


TIME:  14:52     DATE:   2/10/1998


******************************************************************************

     TITLE:  Big Timber Landfill, Cover Alternative
******************************************************************************
```

Sandy loam
Loamy Sand

Alt 3

```
     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                 LAYER  1
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
          THICKNESS                   =      12.00   INCHES
          POROSITY                    =       0.4530 VOL/VOL
          FIELD CAPACITY              =       0.1900 VOL/VOL
          WILTING POINT               =       0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT  =       0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  2.61
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
          THICKNESS                   =      12.00   INCHES
          POROSITY                    =       0.4370 VOL/VOL
          FIELD CAPACITY              =       0.1050 VOL/VOL
          WILTING POINT               =       0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT  =       0.1050 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.170000002000E-02 CM/SEC


                                 LAYER  3
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
```

```
     THICKNESS                      =    600.00  INCHES
     POROSITY                       =      0.6710 VOL/VOL
     FIELD CAPACITY                 =      0.2920 VOL/VOL
     WILTING POINT                  =      0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT     =      0.2920 VOL/VOL
     EFFECTIVE SAT. HYD. COND.      =  0.100000005000E-02 CM/SEC


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
             GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
             AND A SLOPE LENGTH OF  200. FEET.

   SCS RUNOFF CURVE NUMBER              =     62.90
   FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =     20.000  ACRES
   EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =      3.540  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =     10.680  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.584  INCHES
   INITIAL SNOW WATER                   =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS     =    178.740  INCHES
   TOTAL INITIAL WATER                  =    178.740  INCHES
   TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BILLINGS          MONTANA

        STATION LATITUDE                        =  45.48 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   1.70
        START OF GROWING SEASON (JULIAN DATE)   =   130
        END OF GROWING SEASON (JULIAN DATE)     =   278
        EVAPORATIVE ZONE DEPTH                  =  24.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =  11.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  59.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  54.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  47.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  58.00 %


   NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR     BILLINGS           MONTANA

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

   JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
   -------      -------      -------      -------      -------      -------
     0.97         0.71         1.05         1.93         2.39         2.07
     0.85         1.05         1.26         1.16         0.85         0.80


   NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR     BILLINGS           MONTANA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
   -------      -------      -------      -------      -------      -------
    20.90        28.40        33.80        44.60        54.90        64.00
    72.30        70.30        59.40        49.30        35.00        27.10


   NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR     BILLINGS           MONTANA
               AND STATION LATITUDE  =  45.48 DEGREES
```

```
*******************************************************************************

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  0.97     0.71     0.94     1.95     2.50     2.05
                            0.98     1.08     1.15     1.25     0.88     0.85

    STD. DEVIATIONS         0.51     0.38     0.48     1.02     1.22     0.92
                            0.51     0.66     0.78     0.66     0.62     0.55

  RUNOFF
  ------
    TOTALS                  0.006    0.035    0.059    0.087    0.000    0.000
                            0.000    0.000    0.000    0.000    0.001    0.010

    STD. DEVIATIONS         0.024    0.093    0.110    0.215    0.000    0.000
                            0.000    0.000    0.000    0.000    0.008    0.051

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                  0.673    0.517    0.677    1.867    2.542    2.520
                            1.369    0.997    1.072    0.848    0.581    0.538

    STD. DEVIATIONS         0.263    0.214    0.308    0.648    0.810    0.980
                            0.726    0.614    0.649    0.385    0.227    0.252

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS                  0.0027   0.0007   0.0312   0.1567   0.2770   0.2074
                            0.0890   0.0228   0.0337   0.0244   0.0403   0.0195

    STD. DEVIATIONS         0.0175   0.0054   0.0694   0.1745   0.3855   0.2925
                            0.0867   0.0324   0.0446   0.0385   0.0782   0.0491

*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                    INCHES             CU. FEET        PERCENT
                              -------------------   -------------    ---------
  PRECIPITATION                 15.31   (   2.793)     1111542.9      100.00

  RUNOFF                         0.198  (  0.2927)      14393.12        1.295

  EVAPOTRANSPIRATION            14.202  (  2.3669)     1031058.00      92.759

  PERCOLATION/LEAKAGE THROUGH    0.90554 (  0.70181)    65741.914       5.91447
    LAYER  3

  CHANGE IN WATER STORAGE        0.005  (  1.1054)        349.45        0.031
*******************************************************************************
```

```
******************************************************************************

          PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------    -------------
   PRECIPITATION                                2.77        201102.000

   RUNOFF                                       0.699        50724.8086

   PERCOLATION/LEAKAGE THROUGH LAYER  3         0.144173     10466.95310

   SNOW WATER                                   2.93        212376.1090


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.2626

   MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0660

******************************************************************************
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******************************************************************************

              FINAL WATER STORAGE AT END OF YEAR  100
    ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1           3.0621         0.2552

                 2           0.5640         0.0470

                 3         175.1947         0.2920

             SNOW WATER      0.400

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```

APPENDIX C

SOIL TESTING RESULTS

MAXIM
TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF SIEVE ANALYSIS

CLIENT: CITY OF BIG TIMBER MONTANA
C/O MAXIM TECHNOLOGIES, INC.
ATTN: BRIAN GRANT
PO BOX 4699
HELENA, MT 59604

PROJECT: BIG TIMBER LANDFILL

PROJECT NO.: 9731053
REPORT NO.: 2500
DATE OF SERVICE: 2/17/98
AUTHORIZATION: CITY OF BIG TIMBER MONTANA
REPORT DATE: 2/24/98

SERVICES: On February 17, 1998, we received at our laboratory two soil samples from the above referenced project. At your request, we performed sieve anlysis and particle size analysis tests in accordance with ASTM D422 and D1140.

REPORT OF TESTS

BIG TIMBER LANDFILL

	sandy clay loam Stockpile SS-01 LAB NO. 2500-1	sandy loam borrow SS-02 LAB NO. 2500-2
SIEVE ANALYSIS Sieve Size	PERCENT PASSING	
1 1/2"	100	100
1"	98	98
3/4"	96	97
1/2"	91	96
3/8"	88	95
NO. 4	79	92
NO. 10	67	89
NO. 20	66	87
NO. 40	64	85
NO. 80	60	75
NO. 200	54	52
HYDROMETER ANALYSIS (Particle Diameter)		
0.045mm	47	37
0.005mm	28	20
0.003mm	22	15

Composite
TP-1, TP-3.1, TP-3.2

Technician: Jesse Whitford
Engineering Technician

Report Distribution:

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser
Jeremiah B. Bowser, P.E.
Engineering Manager

Our letters and reports are for the exclusive use of the client to whom they are addressed and shall not be reproduced except in full without the approval of the testing laboratory. The use of our name must receive our written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products.

Maxim
600 South 25th Street
P O Box 30615
Billings, MT 59107
(406) 248-9161
FAX (406) 248-9282

TECHNICAL REPORT

REPORT TO: ATTN: BRIAN GRANT
MAXIM TECHNOLOGIES, INC.
P O BOX 4699
HELENA MT 59604

*** REVISED: 03/26/98**	
DATE:	March 17, 1998
JOB NUMBER:	87-911
SHEET:	1 of 3
INVOICE NO.:	25500953

REPORT OF: Soil Analysis - Big Timber Landfill (9731053.200)

SAMPLE IDENTIFICATION:

On February 24, 1998, these soil samples (laboratory numbers 192313 and 192314) were received in our laboratory for analysis. Tests were conducted in accordance with Western States Laboratory Proficiency Testing Program, *"Soil & Plant Analytical Methods"*..

The test results are shown on the following pages.

* Saturated paste electrical conductivity requested on 3/23/98 reported herein.

RECEIVED
MAR 27 1998
MAXIM TECHNOLOGIES
HELENA, MT

Reviewed by ______________________

rmr

As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of our clients and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval. Test results apply specifically to the samples tested only. The entire report shall not be reproduced, except in full, without the written approval of the laboratory. Samples will be disposed of after testing is completed unless other arrangements are agreed to in writing.

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 192313
Sample Name: SS-01
Sample Date: NONE GIVEN
Collected by: NONE GIVEN
Time Sampled: NONE GIVEN
Sample Type: SOIL

Sandy clay loam stockpile, South end of landfill

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Electrical Conductivity Saturated Paste	5.36	mmhos/cm	S-1.20	03/25/98
pH Saturated Paste	7.4	S.U.	S-1.10	03/13/98

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 192314
Sample Name: SS-02
Sample Date: NONE GIVEN
Collected by: NONE GIVEN
Time Sampled: NONE GIVEN
Sample Type: SOIL

Sandy loam borrow area SW of landfill

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Electrical Conductivity Saturated Paste	0.40	mmhos/cm	S-1.20	03/25/98
pH Saturated Paste	7.7	S.U.	S-1.10	03/13/98

APPENDIX D

REVEGETATION INFORMATION

United States
Department of
Agriculture

NATURAL
RESOURCES
CONSERVATION
SERVICE

Hwy. 10 East
P. O. Box 749
Big Timber, MT 59011
(406) 932-5160

March 5, 1998

Brian Grant
MAXIM Technology
P.O. Box 4699
Helena, MT 59604

RECEIVED
MAR 09 1998
MAXIM TECHNOLOGIES
HELENA, MT

Brian,

Here's the information you asked for when I talked with you last week. Enclosed are:

- soil map
- soil descriptions
- aerial photo
- cost estimates
- seeding recommendation

Soils

You were right when you said that the soil at the site is a loam texture. Basically, you have two soils on the property. One is Castner channery loam, which is 10-20" deep over bedrock ("channery" refers to fragments of bedrock mixed together with soil). Castner is loamy-textured from top to bottom of the 20" soil profile. The second soil, Absarokee loam, is a deeper soil, 20-40" deep over bedrock. After the 4" depth, the clay content increases markedly, becoming a clay loam or silty clay loam for the remainder of the profile down to bedrock. Both soils will support revegetation, but the Absarokee will need a little more care in preparing the seedbed.

The pH is between 7.0 and 8.5 for both soils, increasing from the surface down. That should pose no problem for revegetating the site, especially if native grass species are used, which are well-adapted to pH in that range. Neither soil has any other limitations, such as high salinity or sodicity.

RECOMMENDATIONS

Preparing the Site

The soil you described will work alright for revegetating the site. It would be very advantageous to cap it with even 2 inches of loamy topsoil, however. The topsoil will provide good conditions for the seed to germinate, establish and thrive (more neutral pH, better fertility, higher organic matter, etc.).

Naturally, the equipment laying down the soil cover will tremendously compact it, making it inhospitable for revegetation. I talked with Larry Holzworth, NRCS Plant Materials Specialist, Bozeman, and he stressed that it is critical to "rip" or "subsoil" the landfill cap thoroughly (in two directions) to ensure that soil compaction is reduced. This will allow better plant establishment and rooting, as well as infiltration and storage of precipitation for plant use. Ripping will also provide a cloddy, rough surface that will keep wind erosion and dust problems to a minimum prior to planting. I suggest that the cap be laid down during the summer, and that the ripping operation be done by mid-September. At Big Timber, our windy season is from mid-September through March (that's when 75% of our wind energy occurs, with speeds of 40-70 mph common).

Fertilization
The following spring (in March or April), you should consider applying a small amount of fertilizer to help ensure a vigorous planting. This should include approximately 20 pounds each of nitrogen, phosphorus, potassium and sulfur. Higher rates of nitrogen at planting time will increase weed competition during grass establishment.

Seedbed Preparation
Immediately after fertilizing, a fine, weed-free seedbed should be prepared using an off-set tandem disk. This will break down the large clods caused by the ripping operation, loosen the top 3 or 4" of soil, and incorporate the fertilizer. The grass seed is small, so it has to be planted shallow (1/2 - 1"). Plant any deeper, and the emerging seedlings will die before they make it to the soil surface. So, an agricultural "packer" or "roller" must be used after the disking operation to firm up the soil surface and ensure proper seeding depth.

Planting
Now you're ready to plant. I would **strongly** recommend planting native grasses in this situation. This will blend the landfill into the surrounding landscape and will not require maintenance. Introduced grasses are less expensive and are easy to start, but they aren't as adapted to the site as the natives, and after 15-20 years often need to be replanted or renovated in some way. The natives look like they belong here and will be here for the long haul.

A standard double-disk drill with a 6 or 7" row spacing will do the job well. Seeding in two directions will eliminate row visibility, giving it a more natural look. Timing of the seeding is crucial. Planting by the end of April will give the best results, but seedings done as late as mid-May will usually be satisfactory. If planted later than that, it is much less likely that there will be good moisture conditions for grass germination and establishment, and the seedlings will be vulnerable to the heat of July before they establish themselves.

Mulching
The final step is to mulch the seeding. Since the terrain won't be steep, hydro-mulch won't be necessary in this case, and it's expensive (approx. $2,400 per acre). The same results can be accomplished by using weed-free barley or grass straw and "pinning" it, using a disk with the disks set straight. This will anchor the mulch well. If barley straw is used, the

pinning operation should be done when the weather is moist, so the straw isn't too brittle. This will let the straw be pinned, not cut. If grass straw is used, it should be the same species as one of your planted grasses, so you don't introduce seed of an undesirable grass. The standard rate for straw mulch is approximately 3000 pounds per acre.

Weed Suppression

During the summer after planting, it may be necessary to clip the weed growth to a height of 4-6" to minimize competition for light, water and nutrients. It will also reduce weed seed production and will avoid having tumbleweeds (kochia and Russian thistle) blow into fences or across neighboring property. Clipping can be done with either a sickle-bar mower or a swather. If a swather is used, the windrows will need to be baled and destroyed in order to avoid smothering the grass seedlings underneath.

If everything goes well, after two growing seasons, the grass stand should be well-established and vigorous!

If you need further information or have questions, call me at 932-5160.

Sincerely,

Chuck Roloff

Chuck Roloff
District Conservationist

COST ESTIMATES

(costs per acre, in chronological order)

Subsoiling (Ripping)	$15.00	, 2X
Fertilizer, 20-20-20-20	10.75	, plus $25.00 application fee
Disking	8.00	, 2X
Packing Seedbed	4.00	
Seed (native)	48.00	
Seeding	7.00	
Mulching	68.00	(straw and pinning; spreading not included)
Clipping (mower)	7.00	(swather $8.00)
TOTAL est. cost per acre	**$195.00**	

SEEDING RECOMMENDATION

The following seed mix recommendation consists of native, adapted species, that will thrive here and will blend in well with the surrounding landscape. Purchasing certified (vs. common) seed guarantees that you are getting the cultivar that you want, and that the seed is clean and relatively weed-free.

Species	Cultivar	Seeding Rate (lbs./ac.)*	Cost (per lb.)*	Total Cost
Western wheatgrass	Rosana	1.5	$ 9.10	$13.65
Streambank wheatgr.	Sodar	1.25	7.00	8.75
Bluebunch wheatgr.	Goldar	1.75	9.15	16.03
Slender wheatgrass	Pryor	1.5	6.15	9.23
TOTALS		6.0 lbs.		$47.66

* Seed amounts are in pounds of Pure Live Seed

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-CPA-16
2-81

CONSERVATION PLAN MAP

Owner CITY OF BIG TIMBER Operator LANDFILL

County SWEET GRASS State MT Date 3/3/98

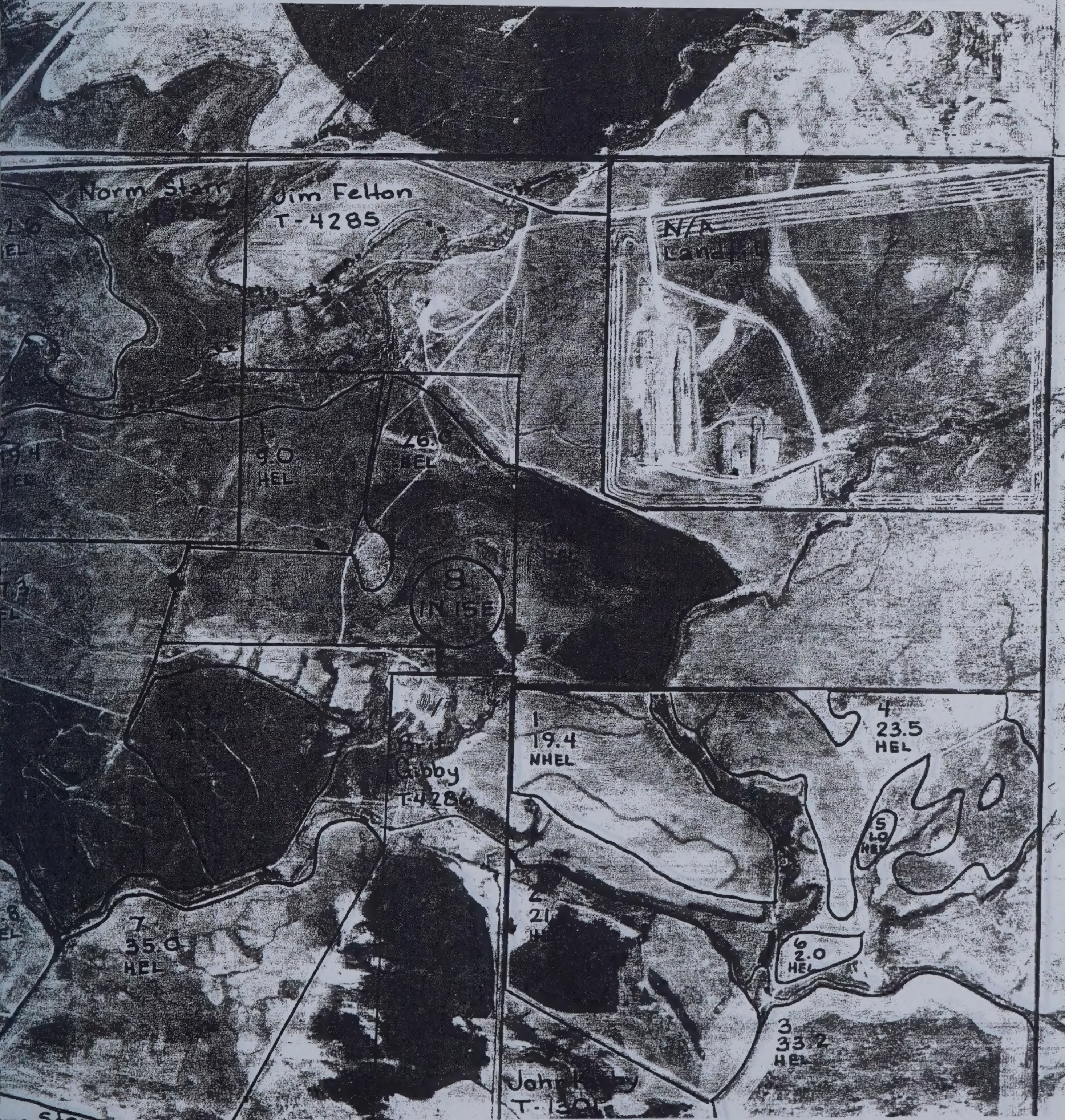
Approximate acres 90 Approximate scale 1" = 660'

Cooperating with SWEET GRASS Conservation District

N

Plan identification Landfill Closing (MAXIM Technology) Photo number

Assisted by Chuck Roloff USDA Soil Conservation Service

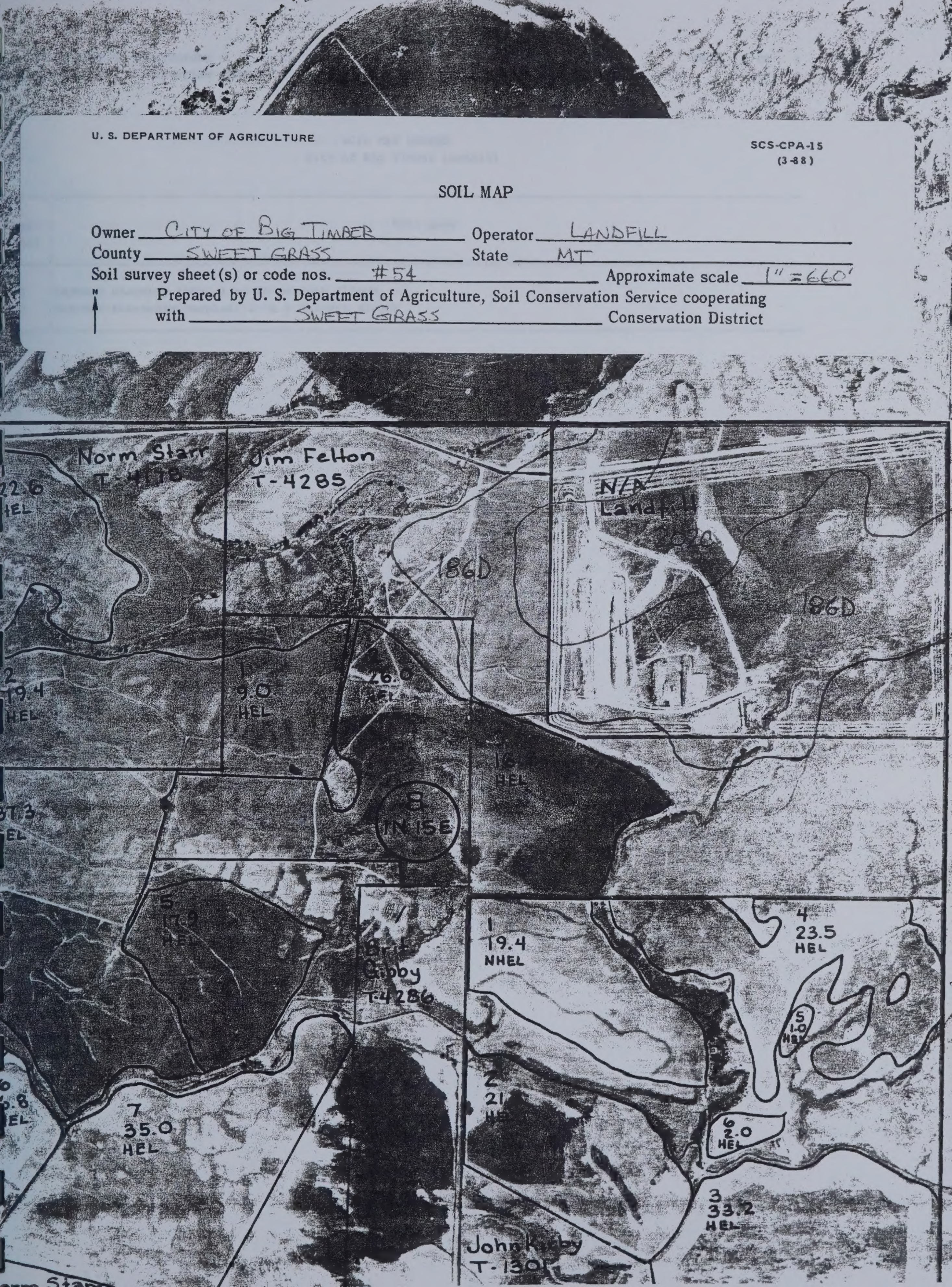

Norm Starr
Jim Felton
T-4285
2.6
HEL
~~N/A~~
Landfill
2
19.4
HEL
1
9.0
HEL
26.6
HEL
T3
EL
8
1N 15E
Brit Gibby
T-4286
1
19.4
NHEL
4
23.5
HEL
5
LO
HEL
8
EL
7
35.0
HEL
2
21
6
2.0
HEL
3
33.2
HEL
John Kirby
T-130

U. S. DEPARTMENT OF AGRICULTURE

SCS-CPA-15
(3-88)

SOIL MAP

Owner CITY OF BIG TIMBER Operator LANDFILL
County SWEET GRASS State MT
Soil survey sheet(s) or code nos. #54 Approximate scale 1" = 660'
N Prepared by U. S. Department of Agriculture, Soil Conservation Service cooperating with SWEET GRASS Conservation District


Norm Starr
T-4178
Jim Felton
T-4285
N/A
Landfill
282C
186D
186D
22.6
HEL
2
19.4
HEL
1
9.0
HEL
2
26.0
HEL
16
HEL
8
1N 15E
37.3
HEL
5
17.9
HEL
Brit
Gibby
T-4286
1
19.4
NHEL
4
23.5
HEL
5
1.0
HEL
6
.8
HEL
7
35.0
HEL
2
21
HEL
6
2.0
HEL
3
33.2
HEL
John Kirby
T-1301
Norm Starr

S. DEPARTMENT OF AGRICULTURE
ATURAL RESOURCES CONSERVATION SERVICE

03/3/98

SOIL MAP LEGEND
City of Big Timber Landfill

Map ymbol	Soil name
6D	Castner channery loam, 2 to 15 percent slopes
2C	Castner-Absarokee complex, 2 to 8 percent slopes

NONTECHNICAL SOILS DESCRIPTION REPORT
City of Big Timber Landfill

Map ymbol	Soil name and description
36D	Castner channery loam, 2 to 15 percent slopes CASTNER CHANNERY LOAM IS 10-20 INCHES DEEP WITH A DARK COLORED SURFACE LAYER AND SLOPES OF 2-15 PERCENT. LANDFORM: NO DATA; FROST FREE DAYS: NO DATA; AVAILABLE WATER CAPACITY IN INCHES: 1.3-1.6; MAJOR CONSIDERATIONS: DEPTH TO HARD ROCK; LANDUSE MAY INCLUDE: CROPLAND, RANGELAND.
02C	Castner-Absarokee complex, 2 to 8 percent slopes ABSAROKEE LOAM IS 20-40 INCHES DEEP WITH A DARK COLORED SURFACE LAYER AND SLOPES OF 2-8 PERCENT. LANDFORM: NO DATA; FROST FREE DAYS: NO DATA; AVAILABLE WATER CAPACITY IN INCHES: 3.6-4.5; MAJOR CONSIDERATIONS: DEPTH TO HARD ROCK; LANDUSE MAY INCLUDE: CROPLAND, RANGELAND.

CHEMICAL PROPERTIES OF THE SOILS
City of Big Timber Landfill

p symbol soil name	Depth	Clay	Cation-exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In	Pct	meq/100g	pH	Pct	Pct	mmhos/cm	
ner---------	0-6	10-18	15.0-20.0	6.6-7.8	---	---	---	---
	6-10	10-18	10.0-15.0	6.6-8.4	0-5	---	---	---
	10-16	10-18	10.0-15.0	6.6-8.4	3-15	---	0-2	---
	16-60	---	---	---	---	---	---	---
ner---------	0-6	10-18	15.0-20.0	6.6-7.8	---	---	---	---
	6-10	10-18	10.0-15.0	6.6-8.4	0-5	---	---	---
	10-16	10-18	10.0-15.0	6.6-8.4	3-15	---	0-2	---
	16-60	---	---	---	---	---	---	---
rokee-------	0-8	20-27	20.0-25.0	6.1-7.3	---	---	0-2	---
	8-23	35-50	25.0-35.0	6.6-8.4	---	---	0-2	---
	23-26	30-40	15.0-20.0	7.4-9.0	15-35	---	0-2	---
	26-60	---	---	---	---	---	---	---

CHEMICAL PROPERTIES OF THE SOILS

dnote -- CHEMICAL PROPERTIES OF THE SOILS

is report shows estimates of some characteristics and features that affect soil behavior. ese estimates are given for the major layers of each soil in the survey area. The estimates e based on field observations and on test data for these and similar soils.

AY as a soil separate consists of mineral soil particles that are less than 0.002 llimeter in diameter. In this report, the estimated clay content of each major soil layer given as a percentage, by weight, of the soil material that is less than 2 millimeters in ameter. The amount and kind of clay greatly affect the fertility and physical condition of e soil. They determine the ability of the soil to adsorb cations and to retain moisture. ey influence shrink-swell potential, permeability, and plasticity, the ease of soil spersion, and other soil properties. The amount and kind of clay in a soil also affect llage and earthmoving operations.

TION EXCHANGE CAPACITY (CEC) is the total amount of cations held in a soil in such way that they can be removed only by exchanging with another cation in the natural soil lution. CEC is a measure of the ability of a soil to retain cations, some of which are ant nutrients. Soils with low CEC hold few cations and may require more frequent plications of fertilizers than soils with high CEC. Soils with high CEC have the potential retain cations, thus reducing the possibility of pollution of ground water.

IL REACTION is a measure of acidity or alkalinity and is expressed as a range in pH lues. The range in pH of each major horizon is based on many field tests. For many soils, lues have been verified by laboratory analyses. Soil reaction is important in selecting ops and other plants, in evaluating soil amendments for fertility and stabilization, and determining the risk of corrosion.

LCIUM CARBONATE is the percentage by weight of calcium carbonate in the fine-earth terial, less than 2 millimeters in size.

PSUM is the percentage by weight of hydrated calcium sulfates 20 millimeters or aller in size, in the soil.

LINITY is a measure of soluble salts in the soil at saturation. It is expressed the electrical conductivity of the saturation extract, in millimhos per centimeter 25 degrees C. Estimates are based on field and laboratory measurements at representative tes of nonirrigated soils.

e salinity of irrigated soils is affected by the quality of the irrigation water d by the frequency of water application. Hence, the salinity of soils in individual fields n differ greatly from the value given in the report. Salinity affects the suitability of soil for crop production, the stability of soil if used as construction material, and e potential of the soil to corrode metal and concrete.

DIUM ADSORPTION RATIO (SAR) expresses the relative activity of sodium ions in change reactions in the soil. SAR is a measure of the amount of sodium relative to lcium and magnesium in the water extract from saturated soil paste.

.S. DEPARTMENT OF AGRICULTURE
ATURAL RESOURCES CONSERVATION SERVICE

good Root penetration
↓ ↓

PHYSICAL PROPERTIES OF SOILS
City of Big Timber Landfill

Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodability index" apply only to the surface layer)

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors K	Erosion factors Kf	Erosion factors T	Wind erodibility group	Wind erodibility index
	In	Pct	g/cc	In/hr	In/in		Pct					
36D:												
Castner---------	0-6	10-18	1.10-1.30	0.60-6.00	0.12-0.14	Low	2.0-4.0	0.20	0.37	1	5	56
	6-10	10-18	1.30-1.55	0.60-6.00	0.06-0.08	Low	1.0-2.0	0.10	0.32			
	10-16	10-18	1.35-1.55	0.60-6.00	0.06-0.07	Low	0.5-1.0	0.10	0.32			
	16-60	---	---	---	---		---	---	---			
02C:												
Castner---------	0-6	10-18	1.10-1.30	0.60-6.00	0.12-0.14	Low	2.0-4.0	0.20	0.37	1	5	56
	6-10	10-18	1.30-1.55	0.60-6.00	0.06-0.08	Low	1.0-2.0	0.10	0.32			
	10-16	10-18	1.35-1.55	0.60-6.00	0.06-0.07	Low	0.5-1.0	0.10	0.32			
	16-60	---	---	---	---		---	---	---			
Absarokee-------	0-8	20-27	1.10-1.30	0.60-2.00	0.16-0.20	Low	3.0-6.0	0.32	0.32	2	6	48
	8-23	35-50	1.20-1.40	0.20-0.60	0.13-0.16	High	1.0-2.0	0.28	0.28			
	23-26	30-40	1.30-1.50	0.20-0.60	0.12-0.15	Moderate	0.5-1.0	0.37	0.37			
	26-60	---	---	---	---		---	---	---			

$K = 0.6-6$ in/hr

$= 4.2 - 12$ cm/sec

$\times 10^{-3}$

PHYSICAL PROPERTIES OF SOILS

dnote -- PHYSICAL PROPERTIES OF SOILS

is report shows estimates of some characteristics and features that affect soil behavior. These estimates e given for the major layers of each soil in the survey area. The estimates are based on field observations d on test data for these and similar soils.

AY as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. this report, the estimated clay content of each major soil layer is given as a percentage, by weight, of the il material that is less than 2 millimeters in diameter. The amount and kind of clay greatly affect the rtility and physical condition of the soil. They determine the ability of the soil to adsorb cations and retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil spersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and rthmoving operations.

OIST BULK DENSITY is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is field moisture capacity, the moisture content at 1/3 bar moisture tension. Weight is determined after ying the soil at 105 degrees C. In this report, the estimated moist bulk density of each major soil rizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in ameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total re space, and other soil properties. The moist bulk density of a soil indicates the pore space available for ter and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist lk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

RMEABILITY refers to the ability of a soil to transmit water or air. The estimates indicate the te of downward movement of water when the soil is saturated. They are based on soil characteristics served in the field, particularly structure, porosity, and texture. Permeability is considered in e design of soil drainage systems, septic tank absorption fields, and construction where the rate of ter movement under saturated conditions affects behavior.

AILABLE WATER CAPACITY refers to the quantity of water that the soil is capable of storing for use by ants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. e capacity varies, depending on soil properties that affect the retention of water and the depth of the root ne. The most important properties are the content of organic matter, soil texture, bulk density, and soil ructure. Available water capacity is an important factor in the choice of plants or crops to be grown and in e design and management of irrigation systems. Available water capacity is not an estimate of the quantity of ter actually available to plants at any given time.

RINK-SWELL POTENTIAL is the potential for volume change in a soil with a loss or gain of moisture. Volume ange occurs mainly because of the interaction of clay minerals with water and varies with the amount and type clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture ntent influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed ods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of ay minerals in the soil and on measurements of similar soils. If the shrink-swell potential is rated moderate very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design often needed. Shrink-swell potential classes are based on the change in length of an unconfined clod as isture content is increased from air-dry to field capacity. The change is based on the soil fraction less an 2 millimeters in diameter. The classes are "Low," a change of less than 3 percent; "Moderate," 3 to 6 rcent; and "High," more than 6 percent. "Very high," greater than 9 percent, is sometimes used.

PHYSICAL PROPERTIES OF SOILS

dnote -- PHYSICAL PROPERTIES OF SOILS--Continued

GANIC MATTER is the plant and animal residue in the soil at various stages of decomposition. In report J, e estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is ss than 2 millimeters in diameter. The content of organic matter in a soil can be maintained or increased by turning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and lth. It is a source of nitrogen and other nutrients for crops.

OSION FACTOR K indicates the susceptibility of the whole soil (including rocks and rock fragments) to eet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The timates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil ructure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible e soil is to sheet and rill erosion by water.

OSION FACTOR Kf is like EROSION FACTOR K but it is for the fine-earth fraction of the soil. Rocks and ck fragments are not considered.

OSION FACTOR T is an estimate of the maximum average annual rate of soil erosion by wind or water that can cur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

ND ERODIBILITY GROUPS are made up of soils that have similar properties affecting their resistance to wind osion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped cording to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

PHYSICAL PROPERTIES OF SOILS

note -- PHYSICAL PROPERTIES OF SOILS--Continued

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

WIND ERODIBILITY INDEX is used in the wind erosion equation (WEQ). The index number indicates the ount of soil lost in tons per acre per year. The range of wind erodibility index numbers is 0 to 300.

SOIL FEATURES
City of Big Timber Landfill

	Bedrock		Cemented pan		Subsidence		Potential frost action	Risk of corrosion	
Map symbol and soil name	Depth	Hardness	Depth	Kind	Initial	Total		Uncoated steel	Concrete
	In		In		In	In			
6D:									
astner---------	10-20	Hard	---	---	---	---	Moderate	High	Low
2C:									
astner---------	10-20	Hard	---	---	---	---	Moderate	High	Low
bsarokee-------	20-40	Hard	---	---	---	---	Low	High	Low

SOIL FEATURES

ote -- SOIL FEATURES

s report gives estimates of various soil features. The estimates are used in land use planning that involves
ineering considerations.

ch to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on
ervations during soil mapping. The rock is either "Soft" or "Hard". If the rock is "Soft" or fractured, excavations
be made with trenching machines, backhoes, or small rippers. If the rock is "Hard" or massive, blasting or
cial equipment generally is needed for excavation.

ented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in
avation. Pans are classified as "Thin" or "Thick". A "Thin" pan is less than 3 inches thick if continuously
urated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines,
khoes, or small rippers. A "Thick" pan is more than 3 inches thick if continuously indurated or more than 18
hes thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is
ded in excavation.

sidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence
ults from either desiccation and shrinkage or oxidation of organic material, or both, following drainage.
sidence takes place gradually, usually over a period of several years. This report shows the expected initial
sidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation. Not
wn in the report is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout
extensive area as a result of lowering the water table.

ential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of
regated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost
ion occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability,
tent of organic matter, and depth to the water table are the most important factors considered in evaluating the
ential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially
ined. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to
st action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil
ength during thawing cause damage mainly to pavements and other rigid structures.

c of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens
oated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture,
ticle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete
based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special
e examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel
tallations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in
tallations that are entirely within one kind of soil or within one soil layer. For uncoated steel, the risk of
rosion, expressed as "Low", "Moderate", or "High", is based on soil drainage class, total acidity, electrical
istivity near field capacity, and electrical conductivity of the saturation extract.

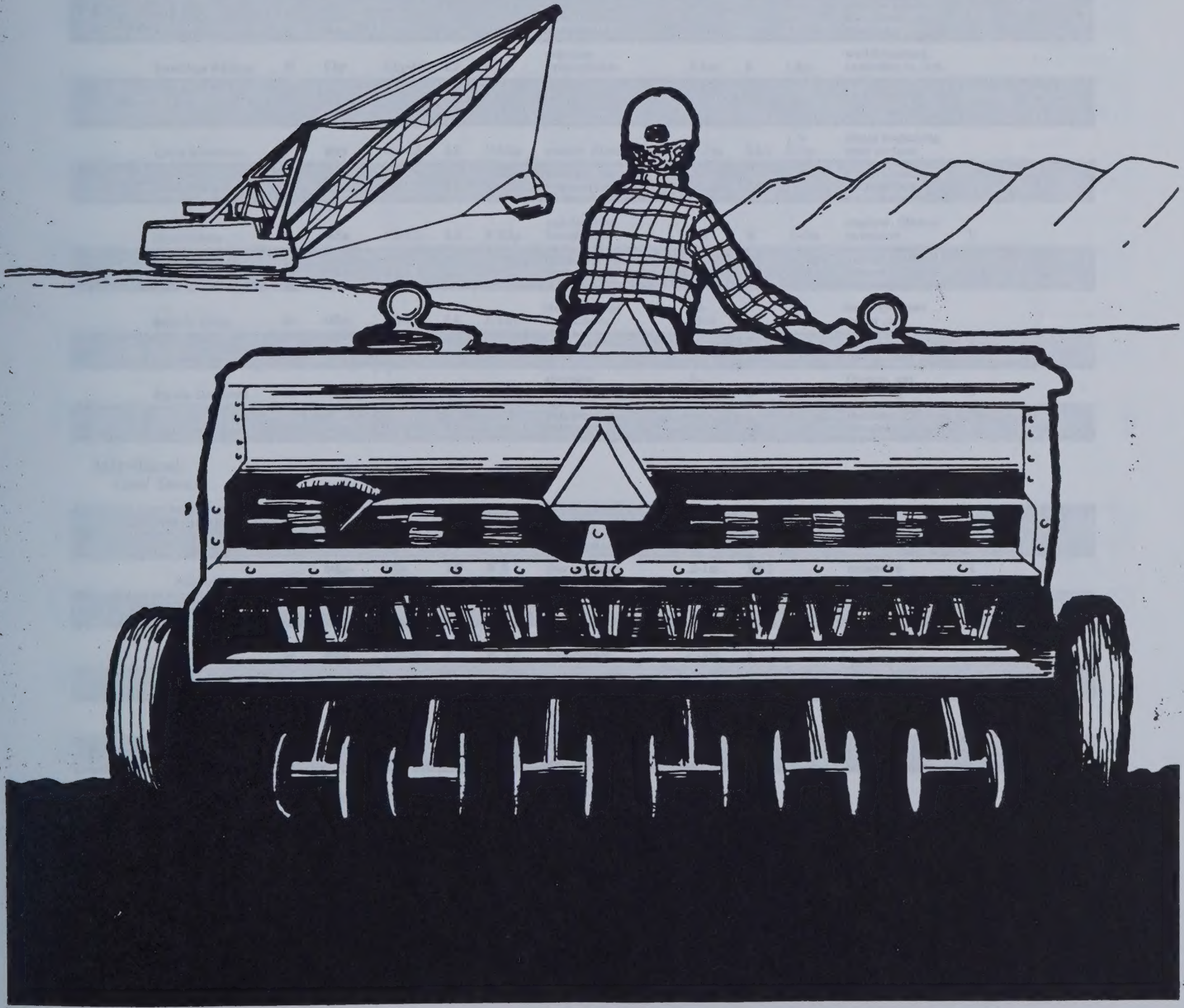
concrete, the risk of corrosion is also expressed as "Low", "Moderate", or "High". It is based on soil texture,
dity, and amount of sulfates in the saturation extract.

Chuck Roloff

Selecting Species for Revegetation

A Guide for Disturbed Lands in the Western Coal Region

ontana Agricultural Experiment Station, Montana State University, Bozeman Special Report 3 May 198



GRASSES:
Natives:
Cool Season:

	1. Establishment ease	2. Begins Growth	3. Optimum growth season	4. Remains green until	5. Dormant periods	6. Specific growth form	7. Plant height	8. Leaf distribution	9. Maximum rooting dep	10. Rooting type	11. Longevity
Wheatgrasses											
Slender	G	ESp	MSp-MS	LF	W, LS-EF	erect bunchgrass	.4-1m	B&S		fibrous	S
Streambank	G	ESp	MSp-MS	LF	LF-W LS-EF	rhizomatous tufted sod-former	.4-.8	S		fibrous, dense	S
Thickspike	G	ESp	MSp-MS	LF	W-ESp MS-EF	strongly rhizomatous sod-former	.5-1m	B&S		fibrous, dense	L
Western	M	ESp	LSp-MS	LF	LS-EF	strongly rhizomatous sod-former	.4-.8m	S	2.2m	fibrous to 1.8m	L
Green Needlegrass	M	Msp	Lsp-Msp	LF	LF-Sp	bunch	.5-1m	B	3.0m	fine-branched	L
Indian Ricegrass	P	ESp	LSp-MS	LF	W MS-EF	erect, tufted bunchgrass	.3-.6m	B		fibrous	L
Prairie Junegrass	P	ESp-Msp	LSp	LF	W ES-EF	erect, tufted bunchgrass	.3-.6m	B&S	.7m	shallow extensive, little branching	
Beardless Wildrye	M	ESp	ESp-MS	LF	W	creeping rhizomatous	.5-1m	B	1.5m	well-branched, extensive to .5m	
Warm Season:											
Little Bluestem	P	Msp	MS-LS	LS	F-ESp	weakly rhizomatous	.5-.5m	B&S	1.5-2.5m	dense branching near surface	
Sand Bluestem	M	Msp	ES-LS	EF	LF-ESp	strongly creeping rhizomatous	1-2.5m	B&S	1m	dense branching near surface	
Blue Grama	P	MSp	ES-LS	LS	F-ESp	sod-forming bunchgrass	.5m	B	.5-1m	shallow, fibrous extensive	L
Sideoats Grama	M	MSp	MS-LS	LS	F-ESp	rhizomatous, bunchgrass or open sod	.5-1m	B&S	2.5m	mostly shallow fibrous	
Buffalo Grass	M	MSp	MS-LS	LS	F-ESp	stoloniferous sod-former	.05-.15m	B	2m	extensive mat upper .5m	
Switchgrass	G	LSp	MS-EF	EF	F-ES	rhizomatous sod-former	1-2m	B&S	2-3.3m	coarse with fine laterals	
Prairie Sandreed	M	Msp	LSp-EF	EF	LF-ESp	strongly rhizomatous	.5-1.5m	B	1-2m	fibrous, ext. branching	L
Sand Dropseed	P	Msp	ESp-MS	LS	F-Sp	rhizomatous, tuft grass	.4-.1m		.6m	shallow fibrous	

Introduced:
Cool Season:

	1. Establishment ease	2. Begins Growth	3. Optimum growth season	4. Remains green until	5. Dormant periods	6. Specific growth form	7. Plant height	8. Leaf distribution	9. Maximum rooting dep	10. Rooting type	11. Longevity
Wheatgrasses											
Crested (standard)	G	ESp-Msp	LSp	LF	W, S	vigorous bunchgrass	.3-1m	B&S	2m	extensive, fibrous	L
Pubescent	G	MSp-ESp	LSp	LF	W,S	rhizomatous sod-former	.5-1m	B&S		extensive fibrous	L
Intermediate	G	LSp-MSp	MS	LF	W, LS	rhizomatous sod-former	1-1.2m	B&S		extensive fibrous	M
Tall	G	MSp	LSp-MS	F	W, LS	tall, tufted bunchgrass	1-.2m	S			
Smooth Bromegrass	G	ESp	MSp-MS	F	W, LS	vigorous rhizomatous sod-former	.4-1.2m	B&S			L
Russian Wildrye	M	ESp	ESp-MS	LF	W., LS	erect bunchgrass	.6-1.5m	B	3m	fibrous, mostly shallow, extensive	
Hard Fescue	M	ESp	ESp-ES	F	W, LS	fine-leaved bunchgrass	.2-.4m	B			
Reed Canarygrass	P	ESp	ESp-ES	F	W, LS	rhizomatous sod-former	.6-2.4m	B&S			

Abbreviations: By column number

1. P = Poor, M = Moderate, G = Good
2.-5. Sp = Spring, S = Summer, F = Fall, W = Winter; E = Early, M = Mid

Explanatory information: By column number

1. General rating for ease by which species is established from seed.
2.-5. Seasonal rather than monthly dates are given to

Table 1. Summary of Plant Characteristics

Environmental Tolerances

GRASSES: Natives: *Cool Season:*	21. Fertility requirements	22. Texture optimum	23. Salt tolerance	24. Na+ tolerance	25. Geographic distribution (Primary)	26. Associated species	27. Grazing tolerance	28. Burning tolerance	29. Topographic adaptati
Wheatgrasses									
Slender		loamy to sandy	M-G		northern and western U.S.	streambank, thickspike	M		bottomlands to uplands
Streambank		silty to sandy	M		northwest and intermountain	bluebunch, thick-prairie junegrass	G		flats and hills
Thickspike	good N response	silty to sandy	M		intermountain region	bluebunch, western wheatgrasses	G	G-Late season	uplands, slopes ridges
Western	good N response	clay to silty	G	M-G	central and western U.S.	blue grama, needle and thread, Idaho fescue	G	G-Late season	uplands, to lowlands
Green Needlegrass	good N response	medium to fine	M		prairies	bluebunch, western wheatgrasses	P		swales to dry hills
Indian Ricegrass	low	sandy, coarse	M		northern and western U.S.	bluebunch, blue grama	G	M-Late season	uplands, slopes ridges
Prairie Junegrass		sandy			N & central prairies	needle & thread, blue grama	G	M	uplands, slopes
Beardless Wildrye	low	sandy, coarse	M-G	M	Western U.S.				slopes to bottomlands
Warm Season:									
Little Bluestem		sandy	P		across U.S., especially prairies	blue grama, sand bluestem	M	P	slopes
Sand Bluestem	good N response	loamy to sandy	P		midgrass to shortgrass prairies	little bluestem	M	M	slopes, uplands (mesic)
Blue Grama	strong N response	clay to sandy	G	M	plains and prairies central and western U.S.	buffalo grass, western wheatgrass, needle and thread	G	P with dry condition, moderate with wet condition	uplands, slopes lowlands
Sideoats Grama	good N response	sandy	M		East of Rockies, especially grassy prairies	Indian grass, bluestems	M-G	rhizomatous/P bunch/G	uplands, slopes ridges
Buffalo Grass		clay to silty	M		plain and prairie, & cent. U.S.	blue grama, western wheatgrass, needle and thread	G	P	uplands, bottomlands
Switchgrass	low to high	sandy	M		Eastern, central, and northern Great Plains	bluestems, sideoats grama, Indiangrass	M	G	mesic lowlands
Prairie Sandreed	low	sandy	M		central, and northern plains	sand bluestem, blowout grass	M		slopes, uplands
Sand Dropseed	low	sandy, coarse	M		Southern and central Plains	bluestems	G	M	variable on open soils
Introduced: *Cool Season:*									
Wheatgrasses									
Crested (standard)	good N responses	clay to silty	M		prairie and plains, Western and Central U.S.	best in pure stands	G	G-Late season	uplands to bottomlands
Pubescent	low	sandy to clay	M-G		plains and Western U.S.		M		uplands to bottomlands
Intermediate	moderate to high	silty to clay	M-P		Northern plains and intermountain	good with legumes	M		uplands to bottomlands
Tall	low	silty to clay	G	G	plains, intermountain and Western		M		bottomlands
Smooth Bromegrass	high N response	sandy to clay	M		Western half of U.S.	good with legumes	G		uplands to bottomlands
Russian Wildrye	moderate	silty to clayey	G		plains and western U.S.	good with warm season grasses	G		uplands and meadows
Hard Fescue	low	sandy 1-clay 1	P		eastern and central U.S.	may be grown with crested wheatgrass	M		slopes and uplands
Reed Canarygrass	moderate	silty to clayey	M-P		across northern U.S. and Western		M		bottomlands and drainage

Abbreviations: By column number

21. N = Nitrogen, G = Good
23.-24. P = Poor, M = Moderate, G = Good
27. P = Poor, M = Moderate, G = Good
28. P = Poor, M = Moderate, G = Good

Explanatory information: By column number

21. Includes information describing plant's fertility requirements or response to fertility amendments.
22. Assessment of soil textural range in which the plant grows.
23. General indication of a plant's ability to tolerate soils considered to be salt affected.
24. Includes any available information assessing a plant's tolerance to sodium affected soils.
25. General description of the plant's geographic range.
26. Plant community types, or species commonly growing with the plant.
27. Assessment of the plant's ability to tolerate grazing pressure.
28. Includes any available information on a plant's ability to survive burning without debilitating injury.
29. Description of the specific types of topographic situations in which the plant grows.

Table 1. Summary of Plant Characteristics

Production Characteristics

	30. Productivity range (kg/ha) (see legend)	31. Optimum haycut phenology	32. Grazing season (optimum)	33. Palatability	34. Growing season nutrition	35. Winter protein	36. Winter energy	37. Range condition indicator	38. Increaser or decreaser (May vary among differing range sites, conditions and seasons of use.)	39. Regrowth
GRASSES:										
Natives:										
Cool Season:										
Wheatgrasses										
Slender	low	heading	W, LSp-MS	G	G	P	G			G
Streambank	low	heading	MSp-MS	M						
Thickspike		before heading	MSp-MS	G	G	M	M	M-G	increaser	
Western	1680 kg/ha	late bloom	ES, F W	G	G	P	G	M-G	increaser	
Green Needlegrass	560 kg/ha	after heading before seed shatter	LSp-ES F-W	E	G	G	G	G	decreaser	G with moisture
Indian Ricegrass		heading	LSp-MS	G	G	G	G	G	decreaser	G with moisture
Prairie Junegrass		heading	LSp-ES	G	G				increaser	F moisture
Beardless Wildrye			MSp-S	M	P	P	M			
Warm Season:										
Little Bluestem	680 to 1820 kg/ha	before heading	MS & F	young/G	G	M	M	G	decreaser	
Sand Bluestem	M	before heading	MS-F	G	G	M	M	G	decreaser	
Blue Grama	500 to 1800 kg/ha	heading	MS-W	G	G	P	G	M-P	increaser	
Sideoats Grama	M	heading	MS-F	G	G	M	M	M-G	decreaser	
Buffalo Grass	low	not for hay	MS-W	G	G	G	G	P-M	increaser	
Switchgrass	G	heading	LSp-LS	E	G	P	P	G	decreaser	
Prairie Sandreed	G	after heading	S, F	G	G	G	G	G-F	decreaser	
Sand Dropseed	L-M	before heading	LSp-MS	young/G cured/P	G	P	P	M-P	increaser (invader)	
Introduced:										
Cool Season:										
Wheatgrasses										
Crested (standard)	1090 kg/ha		ESp-LSp F	early/G	G	P	P			M-F
Pubescent	850 kg/ha	heading	MSp-ES F	early/G	M-G	M-P	M			M
Intermediate	G	bloom	MSp-MS	G	G	M	M			G
Tall	853 kg/ha	bloom	LSp-MS	P	P	M-L	M-L			M
Smooth Bromegrass	900 kg/ha	heading	MSp-MS	G	G	P	P			M
Russian Wildrye	411 kg/ha		MSp-MS F-W	G	G	M-G	G			G with moisture
Hard Fescue	low		ESp-LSp	P	M		P			M-P
Reed Canarygrass	11,000 kg/ha & higher	just before or at heading	MSp-MS	early/G		P	P			with proper management-G

Abbreviations: By column number

30. L = Low, M = Moderate, G = Good
32. Sp = Spring, S = Summer, F = Fall, W = Winter, E = Early, M = Mid, L = Late
33. P = Poor, M = Moderate, G = Good, E = Excellent
34.-36. P = Poor, M = Moderate, G = Good, L = Low
37. P = Poor, M = Moderate, F = Fair, G = Good
39. P = Poor, M = Moderate, F = Fair, G = Good

Explanatory information: By column number

30. Includes general or specific indication of a plant's productivity if good information is available. May vary widely according to site and use.
31. General description of plant's phenology at which hay harvest is usually best made.
33. Assessment of maximum palatability of a plant.
34. Overall assessment of a plant's growing season nutrition for livestock.
35. General rating of a plant's usable winter protein level for livestock and wildlife.
36. General rating of a plant's usable high energy constituents for livestock and wildlife.
37. Range condition which plant's presence and vigor indicates. (If considered a reliable indicator species.)
38. General assessment of plant's survival trend under grazing pressure.

Table 1. Summary of Plant Characteristics

Wildlife

GRASSES:
Natives:
Cool Season:

	40. Species	41. Season	42. Plant part
Wheatgrasses			
Slender	upland, song, small mammal fur and game, browsers	F-W year round	seeds foliage
Streambank	upland song, small mammal fur and game, browsers	F-W year round	seeds foliage
Thickspike	upland, song, small mammals fur and game, browsers	F-W year round	seeds foliage
Western	upland, song, small mammals fur and game, browsers	F-W year round	seeds foliage
Green Needlegrass	song, small mammals, hoofed browsers	LS-W Sp and F	seeds foliage
Indian Ricegrass	upland, song, small mammals hoofed browsers	F-W year round	seeds foliage
Prairie Junegrass	elk, mule deer	Sp, S	foliage
Beardless Wildrye			

Warm Season:

	40. Species	41. Season	42. Plant part
Little Bluestem	antelope, bison	year round	foliage
Sand Bluestem	antelope, bison	year round	foliage
Blue Grama	upland, song, small mammal fur and game, browsers	F-W year round	seeds foliage
Sideoats Grama	upland, song, small mammal fur and game, browsers	F-W year round	seeds foliage
Buffalo Grass	songbirds, waterfowl hoofed browsers	F-W year round	seeds foliage
Switchgrass	about 160 songbirds, upland gamebirds	F-W ES	seeds foliage
Prairie Sandreed	antelope	F-W	foliage
Sand Dropseed	upland, song, small mammal hoofed browsers	F-W year round	seeds foliage

Introduced:
Cool Season:

	40. Species	41. Season	42. Plant part
Wheatgrasses			
Crested (standard)	upland, song, small mammal fur and game, elk, deer	F-W Sp, FW, Sp	seeds foliage
Pubescent	upland, song, small mammal fur and game, elk (good)	F-W year round	seeds foliage
Intermediate	upland, song, small mammal fur and game, elk, deer	F-W F, Sp	seeds foliage
Tall	upland, song, small mammal fur and game, elk (moderate)	F-W Sp, F	seeds foliage
Smooth Bromegrass	upland, song, water fowl, elk, deer	F-W Sp, S, Sp	seeds foliage
Russian Wildrye	deer, elk, antelope	Sp, S, F, W	foliage
Hard Fescue	song, upland, small mammal deer, elk, mountain sheep	F-W W, S	seeds foliage
Reed Canarygrass	upland gamebirds songbirds		seeds

FORBS:
Natives:

	40. Species	41. Season	42. Plant part
Prairie Coneflower	songbirds	F-W	seeds
Lewis Flax	unknown	unknown	unknown
Yarrow	upland, small mammal fur and game, browsers		foliage
Sweetvetch	small mammals rocky mountain goats	F-W S	seeds plant
Purple prairie clover	upland, small mammal fur and game, browsers	year round	foliage
Slender White Prairie	upland, small mammal fur and game, browsers	year round	foliage

SHRUBS:
Natives:

	40. Species	41. Season	42. Plant part
Fourwing saltbush	song, upland, small mammal waterfowl, fur and game hoofed browsers	F-W S-W	seeds twigs, foliage
Nuttall's saltbush	song, upland, small mammal waterfowl, fur and game hoofed browsers	F-W S-W	seeds twigs, foliage
Skunkbush sumac	song, upland, fur and game, hoofed browsers	S-F W	fruit foliage
Serviceberry	song, small mammal, fur and game, browsers	S-F-W S-F	fruit twigs, foliage
Snowberry	song, upland, fur and game, small mammal, hoofed browsers	F-Sp year round	fruit buds, twigs, foliage
Chokecherry	song, upland, small mammal fur and game browsers	F-W	
Indigobush	Bobwhite, muskrat	LS, F	fruit
Big sagebrush	upland, small mammal and game, hoofed browsers	year round W, Sp	foliage, flowers, seed, foliage, twigs
Antelope bitterbrush	small, mammal, upland, fur and game, hoofed browsers	S, F W, Sp	seeds, foliage, foliage, twigs

Abbreviations: By column number

41. Sp = Spring, S = Summer, F = Fall, W = Winter, E = Early, L = Late

Explanatory information: By column number

40. General animal types which rely on the plant for at least some portion of their diet. Animal groups include: upland gamebirds, songbirds, waterfowl, small mammals (mice, gophers, etc.), fur and game mammals (rabbits, squirrels, etc.), and hoofed browsers (deer, elk, antelope, etc.).

41.-42. The season of use and the plant parts used are indicated in these two categories.

Table 1. Summary of Plant Characteristics

Seed Production

	43. Flowering begins	44. Length of flowering period	45. Approximate maturity date	46. Susceptibility to shatter	47. Approved harvest techniques	48. Processing	49. Potential seed yields kg/ha (for lb/acre divide by 1.12)
GRASSES:							
Natives:							
Cool Season:							
Wheatgrasses							
Slender	LSp-ES	determinate	ES-MS	L	combine from windrow	no special problems	560 Irr. 224-448 Dry
Streambank	LSp-ES	determinate	ES	H	windrow or combine direct	break up doubles	224-448 Irr. 112 Dry
Thickspike	LSp-ES	determinate	ES-MS	L	combine from windrow	break up doubles	224-560+ Irr. 112 Dry
Western	LSp-ES	determinate	MS-LS	L	combine from windrow	no special problems	224-560 Irr. 112 Dry
Green Needlegrass	LSp-ES	indeterminate long	ES-MS	H	combine from windrow	deawn	280 Irr. 45 Dry
Indian Ricegrass	LSp-ES	indeterminate	ES-MS	H	direct combine	use debearder to remove pubescence	336 Irr. 112-224 Dry
Prairie Junegrass	MSp	determinate	LSp-ES	H	direct combine	light, chaffy seed	
Beardless Wildrye	LSp	determinate	MS	L	combine from windrow	no special problems	112-224 Irr.
Warm Season:							
Little Bluestem	MS	determinate	LS-F	L	direct combine	difficult, much pubescence	560 Irr. 112-336 Dry
Sand Bluestem	MS	determinate	LS-F	L	direct combine	difficult, much pubescence	90-168 Dry
Blue Grama	MS	determinate	LS	H	direct combine	difficult, light, chaffy	365 Irr. 90 Dry
Sideoats Grama	MS	determinate	LS	H	direct combine	difficult, light, chaffy	448-672 Irr. 112-336 Dry
Buffalo Grass	MS	determinate	LS-F	L	direct combine	break up large burs	20-112 Dry
Switchgrass	MS	determinate	F	L	direct combine	mechanical flail or hammer mill	336-560 112 Native
Prairie Sandreed	MS	indeterminate	F	H	windrow, combine	remove pubescence with debearder	90-230 Irr. 15 kg Dry
Sand Dropseed	MS	determinate	LS	M	direct combine	very small seed	up to 1,120 Irr.
Introduced:							
Cool Season:							
Wheatgrasses							
Crested (standard)	LSp	determinate	ES-MS	M	direct combine	break up doubles	560 Irr. 112-224 Dry
Pubescent	LSp-ES	determinate	MS	L	combine from windrow	no special problems	560 Irr. 224-560 Dry
Intermediate	ES	determinate	MS-LS	L	combine from windrow	no special problems	336-896 Irr. 112-560 Dry
Tall	ES	determinate	LS	L	direct combine	no special problems	560 Irr.
Smooth Bromegrass	LSp-ES LSp-ES	determinate	ES-MS	L	combine from windrow	no special problems	560+ Irr. 224-560 Dry
Russian Wildrye	LSp-ES	determinate	MS	H	combine from windrow	no special problems	112-560 Irr. 56-224 Dry
Hard Fescue		determinate					336-560 Irr.
Reed Canarygrass	MSp	indeterminate	ES	H	windrow or combine direct		56-560 Irr. variable

Abbreviations: By column number

43.-45. Sp = Spring, S = Summer, F = Fall, E = Early, M = Mid, L = Late
46. L = Low, M = Moderate, H = High

Explanatory information: By column number

43. Indicates seasonal range when flowering begins.
44. General type or seasonal length of flowering period.
45. Assessment of average date of seed or fruit maturity. This indicates the general timing of harvest.
46. General rating of the plant's susceptibility to shatter, i.e. the tendency of the plant to drop mature seeds from the inflorescence.
47. The most accepted modes or sequences of harvest operations are given in this category.
48. General or specific assessment of seed cleaning and processing difficulties.

Table 2. Site and Use Characteristics

This table is for preliminary identification of potentially suitable species based on site and use limitations. Consulting Tables 1 and 3 and the text will provide more specific details of the species.

Site characteristics

soil | water & climate

	Texture: coarse (sand)	mod. coarse (sandy)	medium (silty-loamy)	mod. fine (clayey)	very fine (clay)	pH: very acid (low)	slightly acid	neutral	slightly basic	very basic (high)	Salinity: low EC < 4 mmhos	high EC > 4 mmhos	Na+ Problem: no	yes	Fertility: (maximum) low	moderate	high	Erodibility: (maximum) low	moderate	high	Drainage (minimum): poor	moderate	good	Water Table Depth: shallow (0-6")	medium (6-36")	deep (> 36")	Flooding Occurrence: never	infrequent	frequent	Annual Precipitation: 25 cm	26-50 cm
GRASSES:																															
Cool Season:																															
Native:																															
Wheatgrasses–																															
Slender		x	x	x			x	x	x		x	x	x			x			x				x		x			x	x		x
Streambank		x	x	x			x	x	x		x		x			x				x	x				x				x	x	x
Thickspike		x	x	x				x	x		x		x			x				x		x				x		x		x	x
Western			x	x	x				x	x	x	x		x		x				x	x				x				x		x
Green needlegrass			x	x				x	x		x		x			x		x	x		x					x		x			x
Indian ricegrass	x	x						x	x		x		x		x				x				x			x	x				x
Prairie junegrass		x						x					x						x				x			x		x		x	x
Beardless wildrye	x	x							x	x		x		x			x			x	x			x					x		x
Introduced:																															
Wheatgrasses–																															
Crested (standard)			x	x				x	x		x		x			x			x			x				x		x			x
Pubescent		x	x	x			x	x	x		x	x	x			x				x	x	x				x			x		x
Intermediate			x	x				x	x		x		x			x				x		x	x			x		x			x
Tall			x	x					x	x		x		x			x				x				x				x		x
Smooth bromegrass		x	x	x			x	x	x		x	x	x				x			x	x	x			x			x			x
Russian wildrye			x	x					x		x	x	x				x		x		x	x			x			x			x
Hard fescue		x	x	x			x	x	x		x		x			x			x				x			x	x				x
Reed canarygrass			x	x		x	x	x	x		x		x				x			x	x			x					x		x
Warm Season:																															
Native:																															
Little bluestem	x	x						x	x		x		x			x			x	x		x				x		x		x	x
Sand bluestem		x	x					x	x		x		x			x				x		x				x		x		x	x
Blue grama		x	x	x	x			x	x		x	x	x			x			x		x					x	x	x		x	x
Sideoats grama		x						x	x		x		x			x	x		x				x			x		x			x
Buffalo grass			x	x	x			x	x		x		x			x			x		x					x		x		x	x
Switchgrass		x						x			x		x			x	x		x	x	x				x			x			x
Prairie sandreed		x						x	x		x		x		x	x				x			x			x	x				x
Sand dropseed	x	x					x	x	x		x		x		x				x				x			x			x	x	x
FORBS:																															
Native:																															
Prairie coneflower	x	x	x	x	x															x											
Lewis flax							x	x	x										x				x								
Western yarrow	x	x					x	x	x											x		x	x								
Sweetvetch		x	x	x			x	x	x										x												
Purple prairie clover	x	x	x	x	x															x											
Slender white prairie clover	x	x	x	x	x															x											
SHRUBS:																															
Native:																															
Fourwing saltbush			x	x	x				x	x		x		x					x	x			x			x	x	x		x	x
Nuttall's saltbush			x	x	x				x	x		x		x					x	x						x	x			x	x
Skunkbush sumac	x	x					x	x	x			x	x						x	x			x			x					x
Serviceberry		x	x	x			x	x	x		x		x			x	x		x	x					x		x				x
Snowberry			x				x	x	x		x		x			x	x			x		x	x								x
Chokecherry		x	x				x	x	x		x		x			x	x			x			x		x		x				x
Indigobush			x				x	x	x		x		x							x											
Big sagebrush		x	x	x				x	x		x		x			x	x		x	x			x			x	x			x	x
Antelope bitterbrush	x	x	x	x			x	x	x		x		x		x				x	x			x			x	x				x

Table 2 (continued)

	Site														Use characteristics																								
	water & climate																																						
	Drought Occurrence:	infrequent	frequent	**Drought Severity:**	low	moderate	very	***Irrigation Available:**	no	yes	**Winter Temperature Extreme:**	mild	cold	severely cold	**Soil Stabilizer**	**Heavy Traffic Areas**	**Grass Waterways–drainages**	**Rapid Establishment**	**Barrier Plantings–windbrk.**	**Grazing (domestic):**	*Animal Type:*	cattle	sheep	horses	**Use Season:**	Early spring	Late spring	Early summer	Mid-summer	Late summer	Fall	Winter	**Wildlife Food:**	Hoofed browsers	Fur & game mammals	Small mammals	Waterfowl	Upland gamebirds	Songbirds
GRASSES:																																							
Cool Season:																																							
Native:																																							
Wheatgrasses–																																							
Slender		x				x			x					x				x				x	x	x			x	x	x			x		x	x	x		x	x
Streambank			x				x		x					x	x	x						x	x	x			x	x	x					x	x	x		x	x
Thickspike			x				x		x					x	x	x	x					x	x	x			x	x	x					x	x	x		x	x
Western							x		x					x	x		x					x	x	x				x			x	x		x	x	x		x	x
Green needlegrass		x				x			x					x								x	x	x			x	x			x	x		x		x			x
Indian ricegrass			x				x		x					x								x	x	x			x	x						x		x		x	x
Prairie junegrass			x				x		x					x								x	x	x			x	x						x					
Beardless wildrye		x				x			x					x	x							x	x	x			x	x	x	x				x					
Introduced:																																							
Wheatgrasses–																																							
Crested (standard)			x				x		x					x				x				x	x	x		x	x				x			x	x	x		x	x
Pubescent		x				x			x				x		x		x					x	x	x			x	x			x			x	x	x		x	x
Intermediate		x				x			x				x	x	x		x					x	x	x			x	x						x	x	x		x	x
Tall		x				x	x		x					x					x			x					x	x						x	x	x		x	x
Smooth bromegrass			x				x			x				x	x		x					x	x	x			x	x	x					x			x	x	x
Russian wildrye			x				x		x					x								x	x	x			x	x		x	x			x					
Hard fescue		x				x			x					x		x										x	x							x		x		x	x
Reed canarygrass		x				x				x				x	x		x		x			x	x	x			x	x										x	x
Warm Season:																																							
Native:																																							
Little bluestem		x				x	x		x					x	x							x	x	x					x		x			x					
Sand bluestem		x				x			x					x	x							x	x	x					x	x	x			x					
Blue grama			x				x		x					x								x	x	x					x	x	x	x		x	x	x		x	x
Sideoats grama		x				x	x		x					x								x	x	x					x	x	x			x	x	x		x	x
Buffalo grass			x				x		x					x								x	x	x					x	x	x	x		x			x		x
Switchgrass			x				x			x			x	x	x							x	x	x			x	x	x	x								x	x
Prairie sandreed			x				x		x					x	x				x			x	x	x					x	x		x		x					
Sand dropseed			x				x		x					x								x	x	x			x	x	x					x		x		x	x
FORBS:																																							
Native:																																							
Prairie coneflower									x			x			x							x	x																x
Lewis flax									x			x										x	x			x	x												
Western yarrow									x			x			x							x	x				x	x						x	x	x		x	
Sweetvetch									x			x										x	x				x	x	x					x		x			
Purple prairie clover									x			x	x		x							x	x				x	x	x					x	x	x		x	
Slender white prairie clover									x			x	x		x							x	x				x	x	x					x	x	x		x	
SHRUBS:																																							
Native:																																							
Fourwing saltbush			x				x		x				x		x							x	x			x	x				x	x		x	x	x	x	x	x
Nuttall's saltbush			x				x		x				x		x							x	x				x				x	x		x	x	x	x	x	x
Skunkbush sumac			x				x		x				x		x				x								x	x	x					x	x			x	x
Serviceberry		x				x			x				x		x				x							x	x	x	x	x		x		x	x	x		x	x
Snowberry		x				x			x				x		x											x													
Chokecherry		x				x				x			x		x				x													x		x	x	x		x	x
Indigobush		x			x	x			x						x				x																x				x
Big sagebrush			x				x		x				x		x				x			x				x						x		x	x	x		x	
Antelope bitterbrush			x				x		x				x		x				x			x	x			x					x	x		x	x	x		x	

*Irrigation available: No = those species for which irrigation is not necessary for good growth; Yes = those species for which irrigation is required for best results.

Table 3. Seed and Seedling Establishment Characteristics

PLANT ESTABLISHMENT CHARACTERISTICS (seed and seedling characteristics)	SEED								SEEDLING						
	1. Seed Availability	2. Seeding rate (PLS) lb/acre/kg/ha (non-irrigated)	3. Acceptable purity % (average)	4. Acceptable germ %	5. Germination speed (lab evaluation)	6. Cold period required	7. Preplanting treatment	8. 1000 seed wt. (g) (average)	9. Vigor	10. Survival	11. Insect & disease resistance	12. Drought tolerance	13. Flooding tolerance	14. Shading tolerance	15. Optimum planting season
GRASSES:															
Native:															
Cool Season:															
Wheatgrass															
Slender	Surplus	6/6.7	95	85	G	7	no	3.333	G	M	M	M		M	ESp, F
Streambank	Adequate	5/5.6	95	95		no	no	2.841	G	G		G		M	F, ESp
Thickspike	Shortage	5/5.6	88	85		no	no	3.030	M	G		G		M	F, ESp
Western	Adequate	6/6.7	80	80	P	no	no	4.255	M	G		G		M	F, ESp
Green Needlegrass	Shortage	6/6.7	95	24	P	14	H_2SO_4-50 minutes	2.703	G	G	G	M		M	F, ESp
Indian ricegrass	Shortage	6/6.7	94	11	P	30+	H_2SO_4-45 minutes	2.857	G	G		G		P	F, ESp
Prairie junegrass	Shortage	.4/.5			M	no	no	.202	M			G			
Beardless wildrye	Shortage	6/6.7	93	60	M	yes	mech. scarification	2.600				P	G	M	LF, ESp
Warm Season:															
Little bluestem	Shortage	4/4.5	40	60	P	14		1.786	P	G		G		M	LF, ESp
Sand bluestem	Shortage	7/7.8	40	60	P	14		4.292	M			G		P	LF, ESp
Blue grama	Adequate	3/3.4	45	75	P	no		.506	P	M		G		P	Sp
Sideoats grama	Shortage	5/5.6	68	85		no		2.370	M			G			Sp
Buffalo grass	Shortage	4/4.5	83	78	G	30		9.091	M	M		G			F
Switchgrass	Adequate	2/2.2	96	60		14+		1.186	M	G		M			LF, ESp
Prairie sandreed	Shortage	4/4.5	85	75	G	no	fungicide	1.658	P	G		G		P	Sp
Sand dropseed	Adequate	.4/.5				8		.083	P	G		G	P		LF, ESp
Introduced:															
Cool Season:															
Wheatgrasses															
Crested (standard)	Surplus	5/5.6	95	85	G	7		2.353	G		G	G		M	F, ESp
Pubescent	Adequate	7/7.8	90	90		no		5.618	G	G	G	G		M	ESp
Intermediate	Surplus	7/7.8	89	91		no		5.747	G	G	G	M	G	M	ESp
Tall	Surplus	10/11.2	94	90	G	5		6.061	G		G	G		M	F, ESp
Smooth bromegrass	Surplus	5/5.6	92	85	G	5		3.185	G	G	G	M	G	M	ESp
Russian Wildrye	Surplus	6/6.7	91	85		5		2.785	M	G	G	G	M	M	F, ESp
Hard Fescue	Adequate	3/3.4	96	80		no		.768	M	G	G			G	F, ESp
Reed Canarygrass	Surplus	4/4.5	96	80		no		.844	P	G	G	P	G	M	ESp
FORBS:															
Prairie coneflower	Shortage	4/4.4	80	80				.200	M	G		G			MSp-LSp
Lewis flax	Shortage	8/8.9	90	80	M			1.550	G	G	G	G			F, ESp
Western yarrow	Shortage	1/1.1	50		M-G	no		.369	M						ESp
Sweetvetch	Shortage	6/6.7	85	(4)			mech. scarification	5.263	M	M	M	G			ESp
Purple prairie clov.	Shortage	3/3.4	90	48	M-G		mech. scarification	1.500	G	G	G	G			LSp
Slender wht. pr. clov.	Shortage	3/3.4	90	48	M-G		mech. scarification	1.500	G	G	G	G			LSp
SHRUBS:															
Fourwing saltbush	Surplus	13/14.6	85	21		no	de-wing	11.010	G	M	P	G		M	Sp
Nuttall's saltbush	Shortage	7/7.8	85			no	de-wing	3.215	M	M	M	G		M	Sp
Skunkbush sumac	Shortage	40/44.8	90			no	H_2SO_4-1 hour	20.833	P	G	M	G			F, Sp
Serviceberry	Shortage	8/8.9	95			120-180	prechill	5.537	M	M	G	M		M	F
Snowberry	Shortage	12/13.4	90			180	prechill-cold	5.974	P	G	G	M			F
Chokecherry	Shortage	182/203.8	95			120-160	stratification	94.787	M	G	M	P		M	F
Indigobush	Shortage	3/3.4	97	63			H_2SO_4-5-8min-moist	1.437	M						ESp
Big sagebrush	Adequate	.3/.3	10			yes	stratification	.184	P	G	M	G			F, ESp
Antelope bitterbrush	Surplus	58/65.0	95	85	G	yes	3% thioures for 3-5 min.	29.481	M	G	G			G	F, ESp

LEGEND:

1. Availability assessment based on indications of quantities and prices from commercial suppliers. (As of Jan. 1980)
2. Seeding rates are those recommended in the literature or represent 220 seeds/m^{-2} (20 seed/ft^{2}). Since many of the species are intended not for pure stand use, but rather for floristic diversity, drainage stabilization and wildlife food and cover, *seeding rates may be adjusted to suit the intended use, achieve desired plant densities, and compensate for interspecific competition.*
3. Average purity of reasonable quality available seed.
4. Average germination of reasonable quality available seed.
5. Germination speed refers to a general assessment of the rapidness of seed to germinate under prescribed test conditions.
6. Known stratification requirements (,).
7. Known germination or emergence enhancement treatments.
8. Average seed weight.
14. Existing information categorized as Good (G), Moderate (M), Poor (P).
15. Spring–Sp, Fall–F, Early–E, Mid–M, Late–L. Where two seasons are listed the first listing indicates the better planting period.

Blank Spaces in the table indicate a lack of information.

GRASSES & GRASSLIKE SPECIES
SPECIES CHARACTERISTICS AND ADAPTATIONS

Scientific Name Common Name	Height*	Cool Season or Warm Season	Bunchgrass, Sodformer or Annual	Native or Introduced	Minimum Amount of Precipitation (inches)	SOIL TEXTURE					SOIL pH			Seeding Rate **	Seeds per Pound	Planting Time†	Varieties
						Coarse	Moderately Coarse	Medium	Moderately Fine	Fine	Acidic	Neutral	Basic				
Bromus inermis Smooth brome	M	C	S	I	12-18	1	3	3	3	1	1	3	2	8	125,000	F/S	Lincoln, Manchar
Bromus marginatus Mountain brome	T	C	B	N	16	0	1	3	3	1	0	3	1	10	90,000	late S	Bromar
Bromus mollis Soft chess or Blando brome	S-M	C	A	I	12	1	2	3	3	1	0	3	1	6-8	265,000	F	Blando
Bromus rubens Red brome	S-M	C	A	I	11	1	3	3	3	1	0	3	1	6	270,000	F/S	Panoche
Buchloe dactyloides Buffalograss	S	W	S	N	12	0	1	3	3	2	0	3	2	4-8	56,000	S	Texoka, see also Turfgrasses section
Calamagrostis canadensis Bluejoint reedgrass	T	C	S	N	W‡	0	2	3	3	1	2	2	1	2	2,270,000	F/S	Sourdough
Calamovilfa longifolia Prairie sandreed	T	W	S	N	12	3	3	2	1	0	1	3	1	3-4	273,000	S	Goshen
Carex aquatilis Water sedge	T	C	S	N	W‡	0	0	1	3	2	0	3	2	5	485,000	F/S	
Carex bebbii Bebb's sedge	S-T	C	B	N	W‡	0	0	1	3	2	0	3	2	2	1,402,000	F/S	
Carex nebraskensis Nebraska sedge	M-T	C	S	N	W‡	0	0	1	3	2	0	3	2	5	534,100	F/S	
Carex rostrata Beaked sedge	M-T	C	S	N	W‡	0	0	1	3	2	0	3	2	7	444,000	F/S	
Cenchrus ciliaris Bufflegrass	M-T	W	B	I	11	1	3	3	2	0	0	3	1	3	440,000	F/S-Sum	Nueces
Cynodon dactylon Giant bermudagrass	M-T	W	S	I	10	1	2	3	2	0	0	3	2	15	2,000,000	S-Sum	See Turfgrasses section
Dactylis glomerata Orchardgrass	M-T	C	S	I	18	0	1	3	2	1	2	3	0	2-3	654,000	S	Latar, Paiute Potomac
Deschampsia caespitosa Tufted hairgrass	M	C	B	N	20	0	1	3	3	1	2	3	0	1-2	2,500,000	F	
Distichlis stricta Inland saltgrass	S-M	W	S	N	8	0	1	2	3	3	0	1	3	10	520,000	Sum	
Eleocharis parvula Spikerush	S	C	S	N	W‡	0	0	1	3	2	0	2	3	4	754,000	F/S	
Elymus angustus (see *Leymus angustus*)																	
Elymus canadensis Canada wildrye	T	C	B	N	12	3	3	2	1	0	0	3	2	7	115,000	F/S	
Elymus cinereus (see *Leymus cinereus*)																	
Elymus elymoides Bottlebrush squirreltail	M	C	B	N	6	1	3	3	3	1	1	3	2	8-10	192,000	F	
Elymus giganteus (see *Leymus racemosa ssp. racemosa*)																	
Elymus glaucus Blue wildrye	M-T	C	B	N	13	1	3	3	1	0	0	3	1	9	110,000	F/S	
Elymus junceus (see *Psathyrostachys juncea*)																	
Elymus lanceolatus ssp. dasystachyum Thickspike wheatgrass	M	C	S	N	8	2	3	3	2	0	0	3	1	6-8	154,000	F/S	Bannock, Critana
Elymus lanceolatus ssp. riparium Streambank wheatgrass	S-M	C	S	N	8	0	1	3	3	2	0	3	1	6-8	156,000	F/S	Sodar

Soil Adaptation Codes: 0=Not adapted 1=Marginal, 2= Average, 3= Best

* Height: Short (S) 1 to 12 inches; Medium (M) 13 to 24 inches; Tall (T) 25 inches or taller

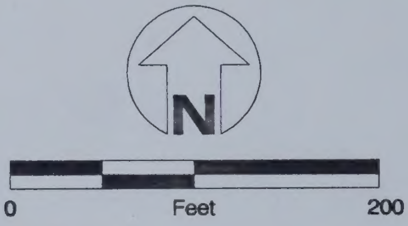
** Seeding Rate: Pure live seed (PLS) pounds per acre

† Planting Time: F=Fall; F/S=Fall or Spring; S=Spring; Sum=Summer

‡ W=adapted to wetlands

EXHIBITS

, APPROXIMATING ORIGINAL GROUND



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of 3	Sheet Title: **Site Plan**
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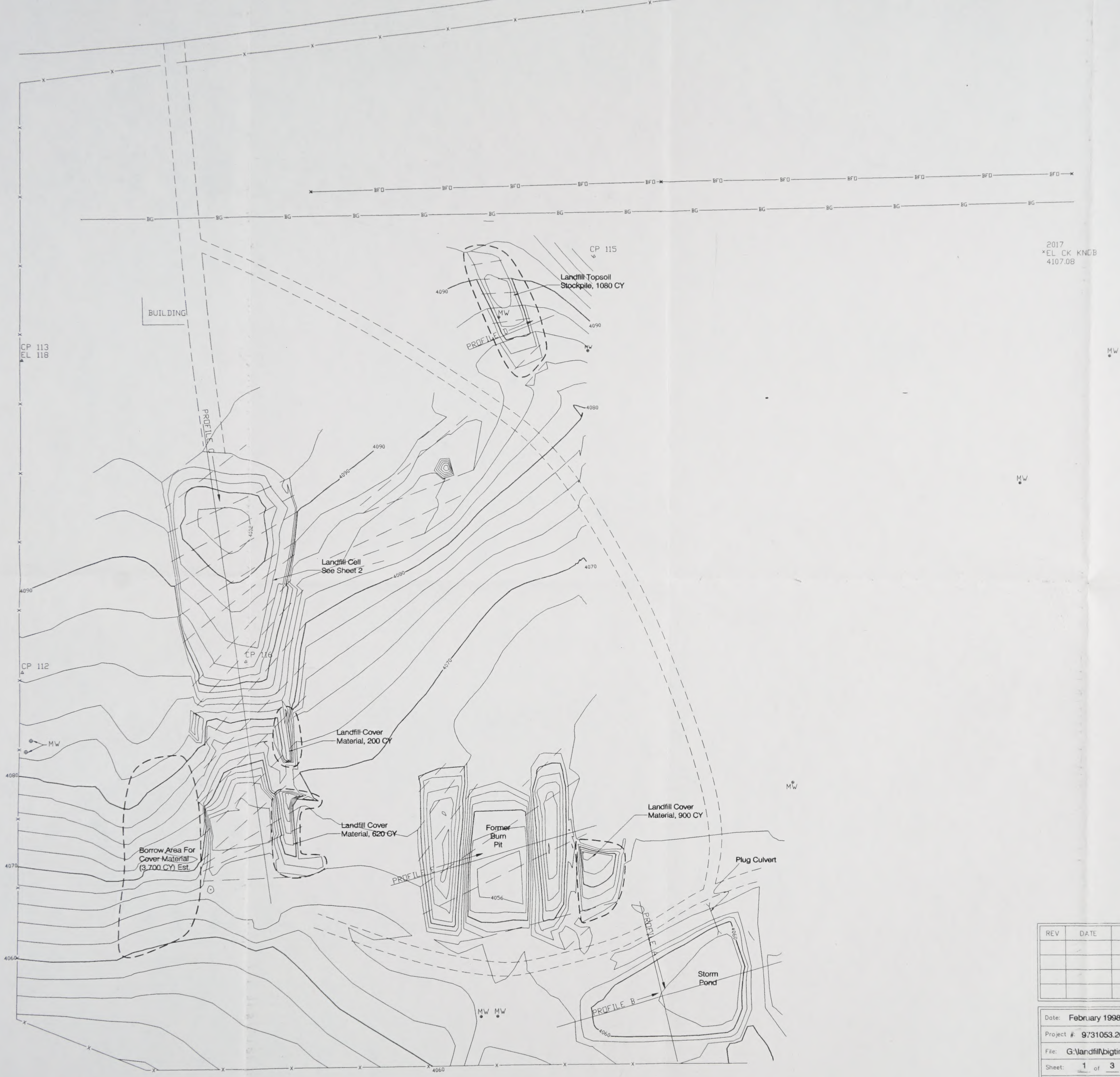
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BG
CP 115
2017
×EL CK KNOB
4107.08
Landfill Topsoil Stockpile, 1080 CY
4090
MW
PROFILE D
4090
MW
MW
BUILDING
CP 113
EL 118
4080
PROFILE C
4090
4090
4102
MW
Landfill Cell See Sheet 2
4080
4070
4090
CP 112
CP 116
4070
Landfill Cover Material, 200 CY
MW
4080
Landfill Cover Material, 620 CY
Former Burn Pit
4056
Landfill Cover Material, 900 CY
MW
Plug Culvert
Borrow Area For Cover Material (3,700 CY) Est.
4070
PROFILE E
PROFILE A
4060
Storm Pond
PROFILE B
4060
MW MW
4060
4060

LEGEND

BFO BURIED FIBER OPTIC
BG BURIED GAS
MW MONITORING WELL
CP 60d NAILS SET BY M/M
EXCEPT AS NOTED
—— CONTOUR LINES
APRROXIMATING ORIGINAL GROUND

N

0 Feet 200

REV	DATE	DESCRIPTION	DRN BY	APP BY

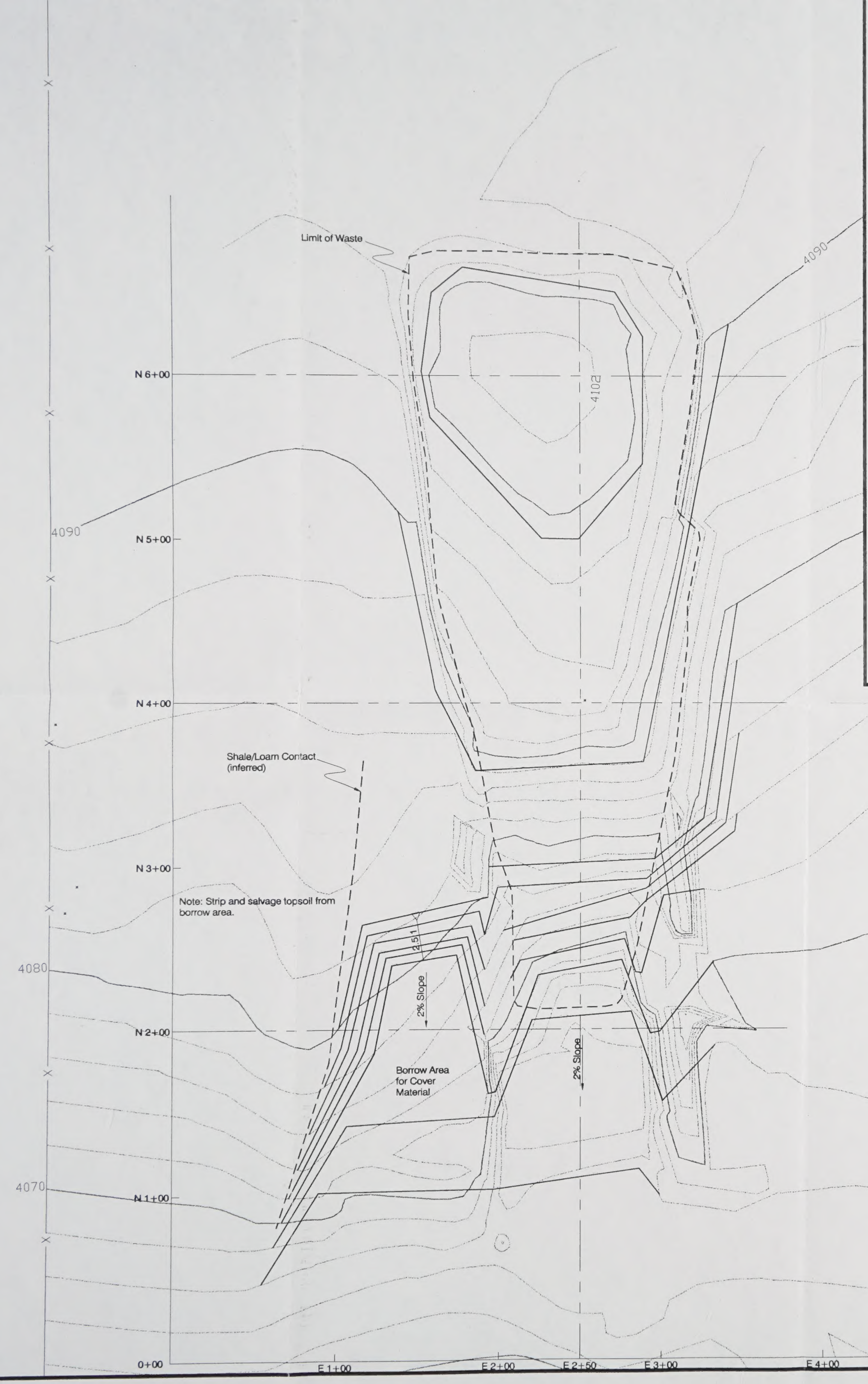
Date: February 1998
Project #: 9731053.200
File: G:\landfill\bigtimbr\sheet1.dwg
Sheet: 1 of 3

MAXIM TECHNOLOGIES INC
MORRISON MAIERLE, INC.

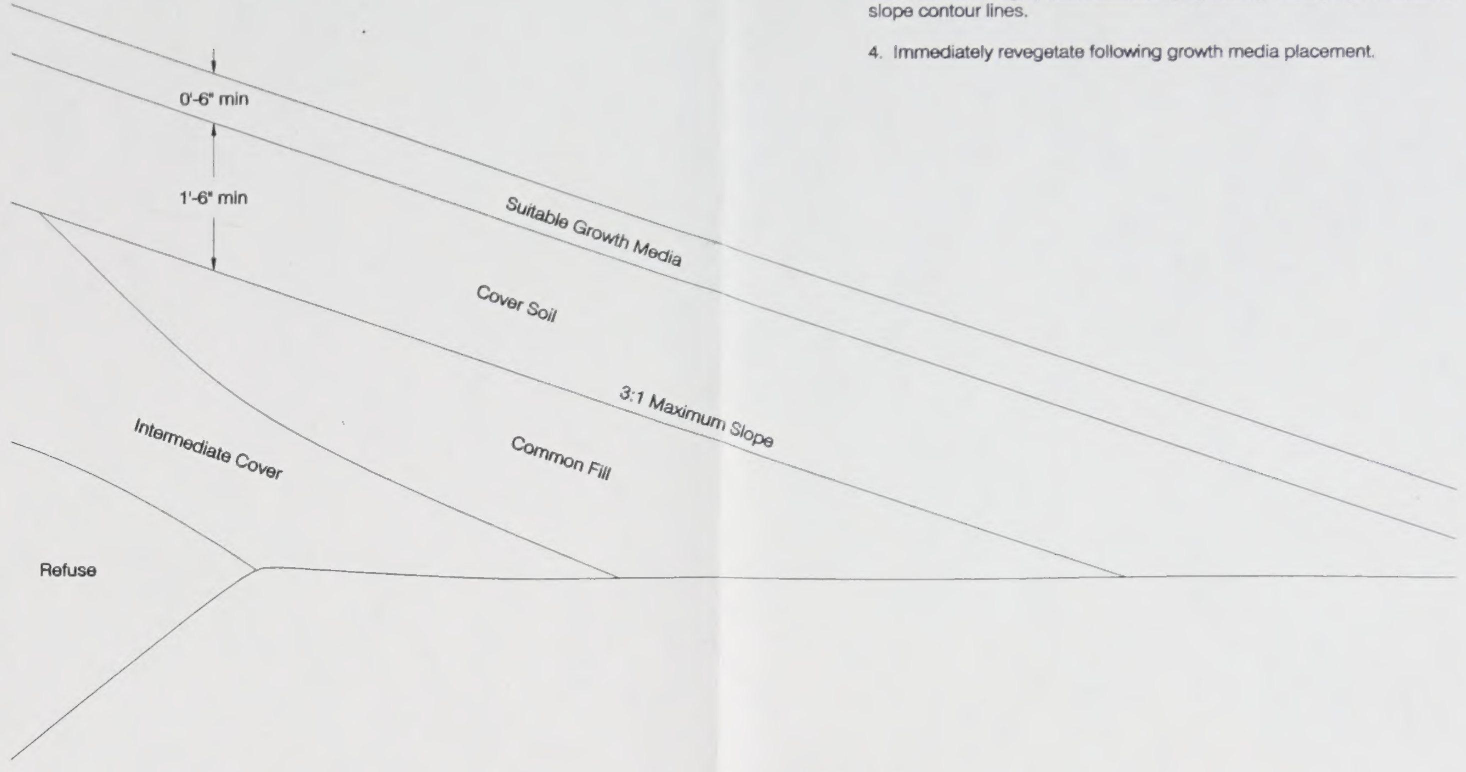
Project Title: Landfill Closure

Sheet Title: Site Plan

SHEET 1


Limit of Waste
4090
4102
4090
4080
4070
4070
N 6+00
N 5+00
N 4+00
N 3+00
N 2+00
N 1+00
0+00
E 1+00
E 2+00
E 2+50
E 3+00
E 4+00
Shale/Loam Contact (inferred)
2.5:1
2% Slope
2% Slope
Borrow Area for Cover Material
4056
N
0
Feet
100

Note: Strip and salvage topsoil from borrow area.


0'-6" min
1'-6" min
Suitable Growth Media
Cover Soil
3:1 Maximum Slope
Intermediate Cover
Common Fill
Refuse

Cover Detail
No Scale

Notes:

1. Place common fill as needed to achieve 3:1 maximum slope across landfill surface.

2. Place cover soil in two loose lifts. Complete placement using a dozer and thoroughly track each lift.

3. Place growth media in a single loose lift. Complete placement using a dozer and thoroughly track each lift by operating dozer perpendicular to slope contour lines.

4. Immediately revegetate following growth media placement.

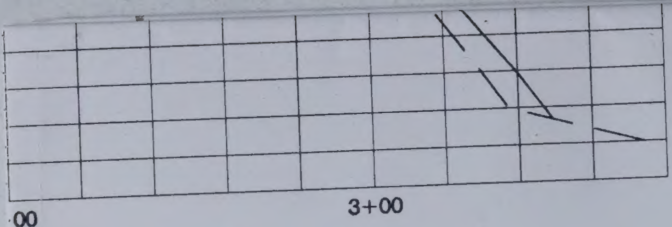
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: February 1998
Project #: 9731053.200
File: G:\landfill\bigtimbr\site1-50.dwg
Sheet: 2 of 3

MAXIM TECHNOLOGIES INC
MORRISON MAIERLE, INC.

Project Title: Landfill Closure

Sheet Title: Cell Closure Plan SHEET 2



4+00

Scale

Horizontal 1:50
Vertical 1:10

ATE	DESCRIPTION	DRN BY	APP BY

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731053.200
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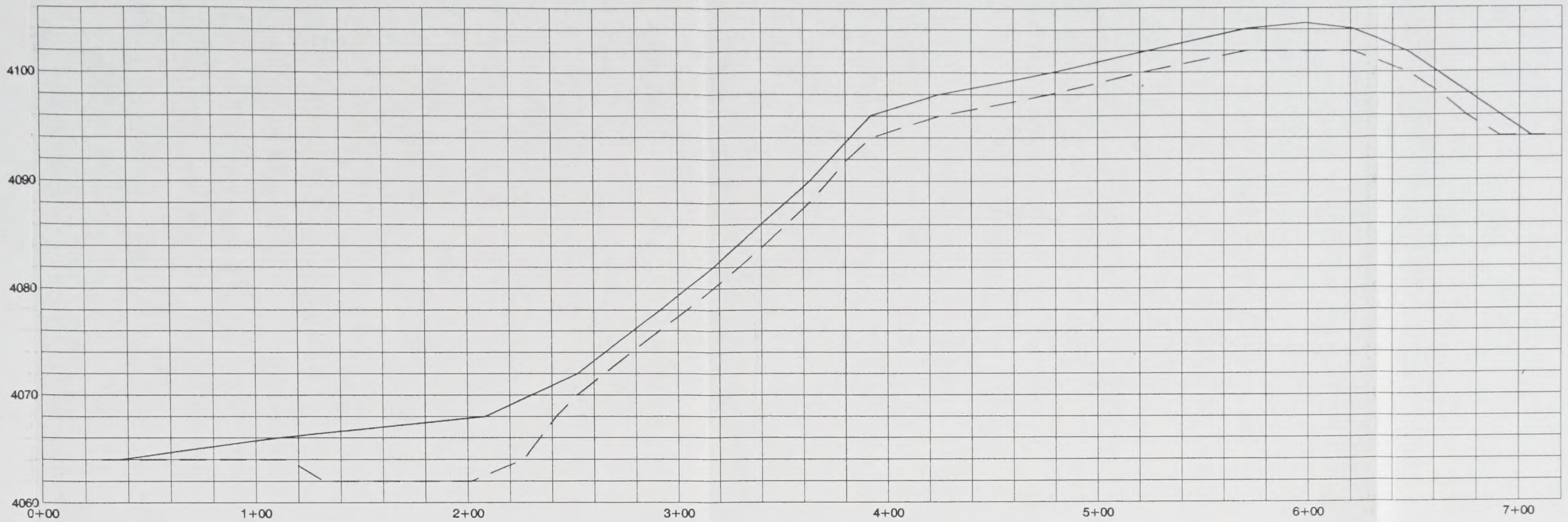
OGIES INC

MORRISON
MAIERLE, INC.

Project Title: **Landfill Closure**

Sheet Title: **Sections**

SHEET 3



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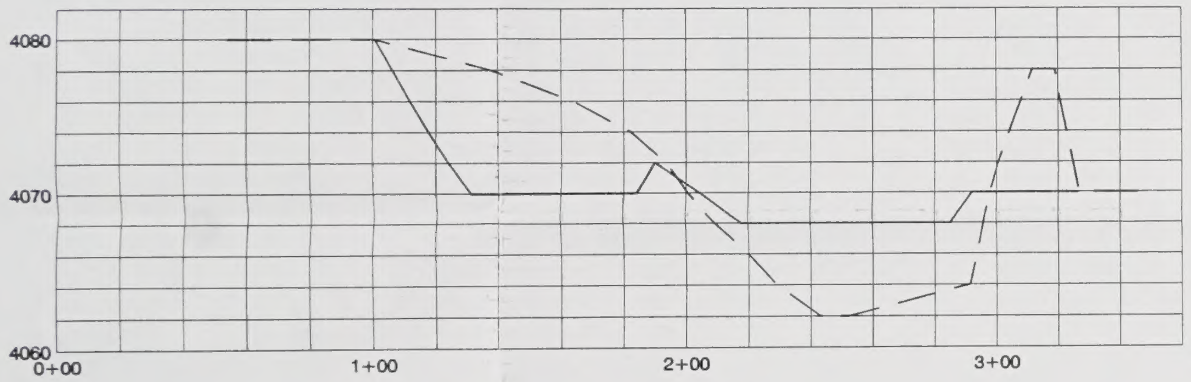

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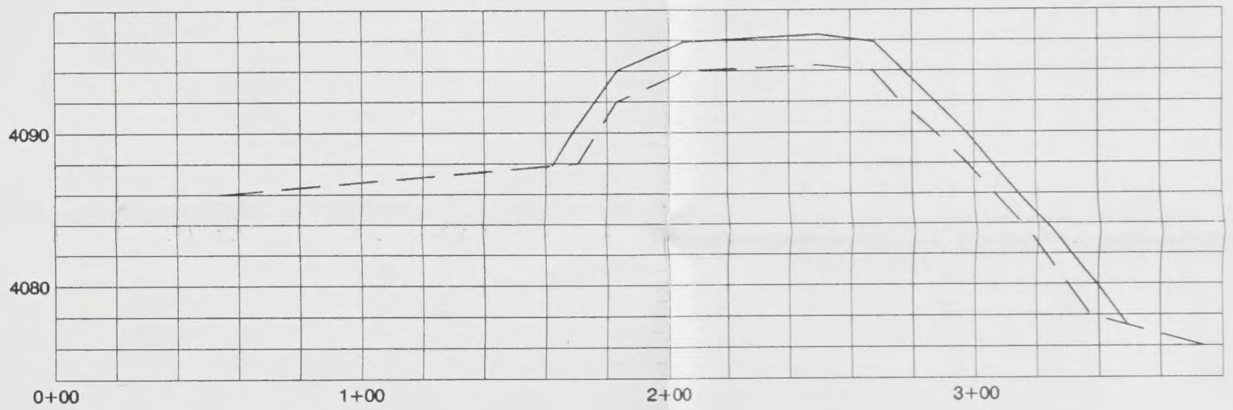

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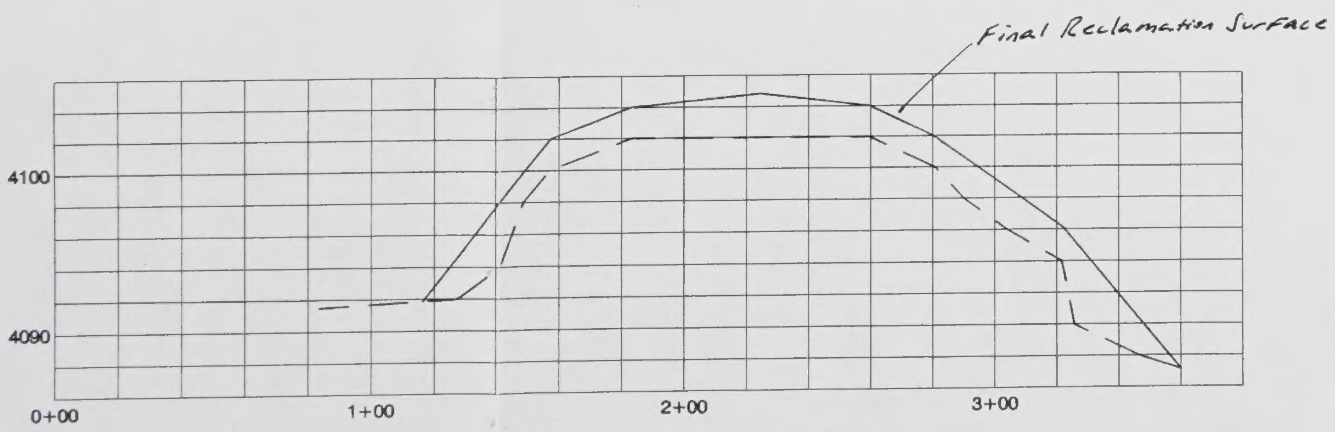

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Scale
Horizontal 1:50
Vertical 1:10

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: February 1998
Project #: 9731053.200
File: G:\landfill\bigtimbr\sections.dwg
Sheet: 3 of 3

MAXIM TECHNOLOGIES INC
MORRISON MAIERLE, INC.

Project Title: Landfill Closure

Sheet Title: Sections

SHEET 3

TETRA TECH

RECEIVED
APR 2 5 2023
DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

April 25, 2023

Mr. Kris Novotny
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: Post-Closure Site Inspection
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 117-8033001

Dear Mr. Novotny:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech, Inc. (Tetra Tech) on April 24, 2023, at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.1404. This was the 26th year of the 30-year post closure monitoring period.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site. An inspection of methane monitoring points and monitor wells was also conducted.

No areas of subsidence were observed above or around the waste cell or burn pit. The general appearance of the closed landfill and vegetative cover throughout the site remains in good condition. Some minor revegetation issues were again observed; however, areas previously noted as having sparse vegetation continue to be improving, and these areas are not associated with locations where waste was buried. No rills or gullies were observed which would demonstrate active erosion. Most areas with poor to fair vegetative cover also continue to display a large percentage of surface coarse fragments, which are armoring soils from further wind erosion.

Fencing along the property boundary is in very good condition and no damaged fencing was observed. The area around the building is leased to an area contractor and currently storing heavy equipment and building materials. Methane monitoring point BTM-3 was observed not to have a lock; however, the steel cover is rusted closed.

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WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

Post-Closure Site Recommendations

Tetra Tech does not recommend any additional work at this time. However, since the likelihood of using the monitor wells and methane monitoring points is not likely we recommend a plan and budget for well abandonment be considered soon. For your convenience, we have forwarded a copy of this report to the Montana Department of Environmental Quality (MDEQ). If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech, Inc.

Jake Conver

Jake Conver, P.E.	Jeff R. Rice
Project Engineer	Environmental Group Manager

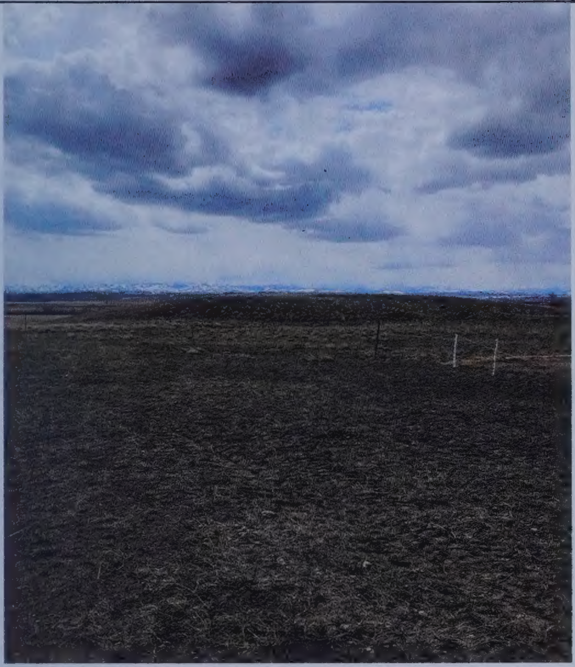
JC/JRR/ba

Attachment: Photographs

cc: Mike Eder MDEQ, Helena, MT, delivered via email mike.eder@mt.gov

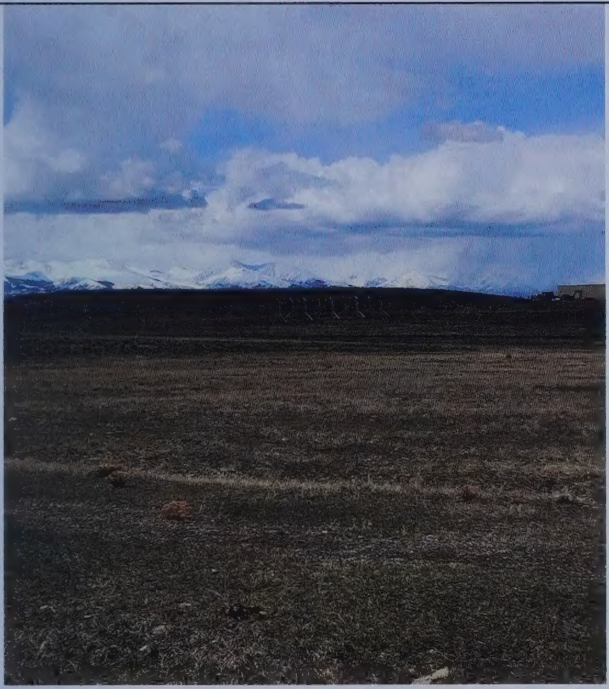
I:\A-G\Big Timber City Of\117-8033001 - Big Timber LF Site Inspection\05-Deliverables\Final\2023Post Closure\Big Timber Landfill 2023.docx

BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
April 24, 2023
Tetra Tech Project No.: 117-8033001

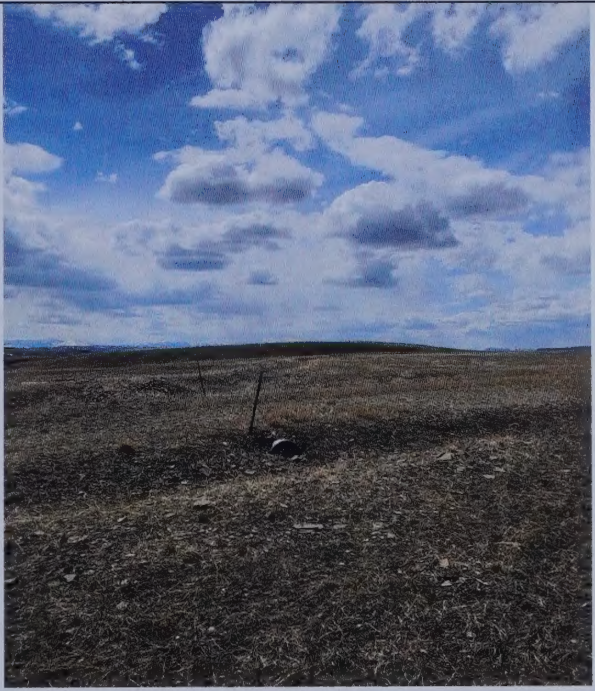


PHOTOGRAPH 1 Looking southwest toward former waste cell.

PHOTOGRAPH 2 Looking southwest from top of former waste cell.



PHOTOGRAPH 3 Looking west/northwest at the former waste cell and catch fence.



PHOTOGRAPH 4 Looking southwest from the former haul road.

Closed

#308 Sweetgrass

TETRA TECH

RECEIVED
APR 23 2021
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

April 23, 2021

Mr. Kris Novotny
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: **Post-Closure Site Inspection**
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 117-8033001.300

Dear Mr. Novotny:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech, Inc. (Tetra Tech) on April 20, 2021 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.1404. This was the 24th year of the 30-year post closure monitoring period.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site. An inspection of methane monitoring points and monitor wells was also conducted.

No areas of subsidence were observed. The general appearance of the closed landfill and vegetative cover throughout the site remains in good condition. Some minor revegetation issues were again observed; however, areas previously noted as having sparse vegetation appear to be improving, and these areas are not associated in locations where waste was buried. No rills or gullies were observed which would demonstrate active erosion. Most areas with poor to fair vegetative cover also continue to display a large percentage of surface coarse fragments, which are armoring soils from further wind erosion.

Fencing along the property boundary remains in good condition and no damaged fencing observed. The area around the building is continuing to be used for equipment and materials storage for the City of Big Timber. Methane monitoring point BTM-3 was observed not to have a lock; however, the steel cover is currently rusted closed.

Tetra Tech
7100 Commercial Avenue Suite 4, Billings, MT 59101
Tel 406.248.9161 Fax 406.248.9282 www.tetratech.com

Post-Closure Site Recommendations

Tetra Tech does not recommend any additional work at this time. However, since the likelihood of using the monitor wells and methane monitoring points is not likely we recommend a plan and budget for well abandonment be considered soon. For your convenience, we have forwarded a copy of this report to the Montana Department of Environmental Quality (MDEQ). If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech, Inc.

Jake Conver, P.E.
Project Engineer

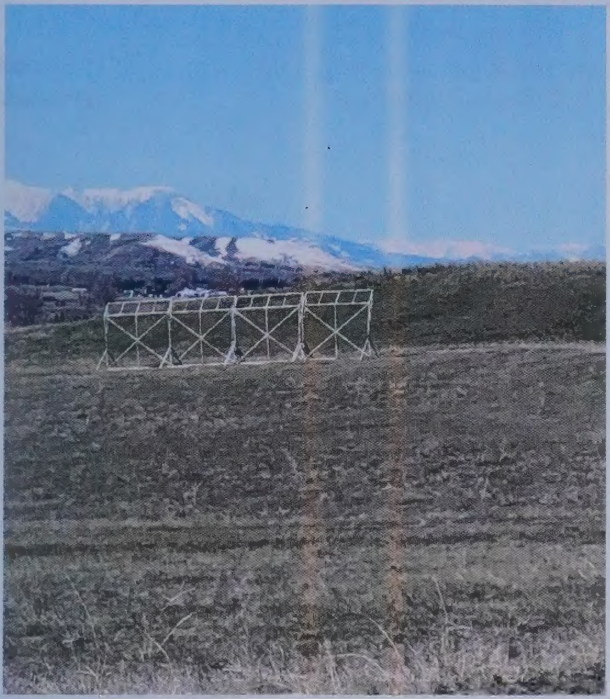
Jeff R. Rice
Environmental Group Manager

JC/JRR/ba

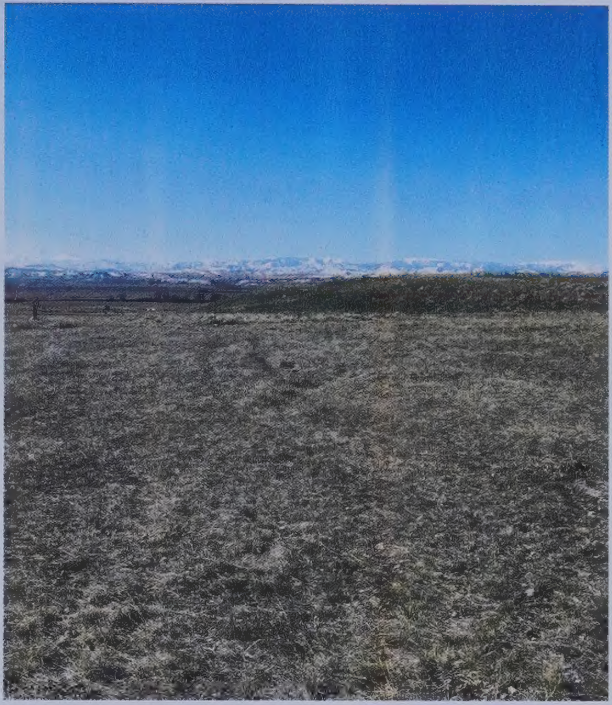
Attachment: Photographs

cc: Mike Eder MDEQ, Helena, MT, delivered via email mike.eder@mt.gov

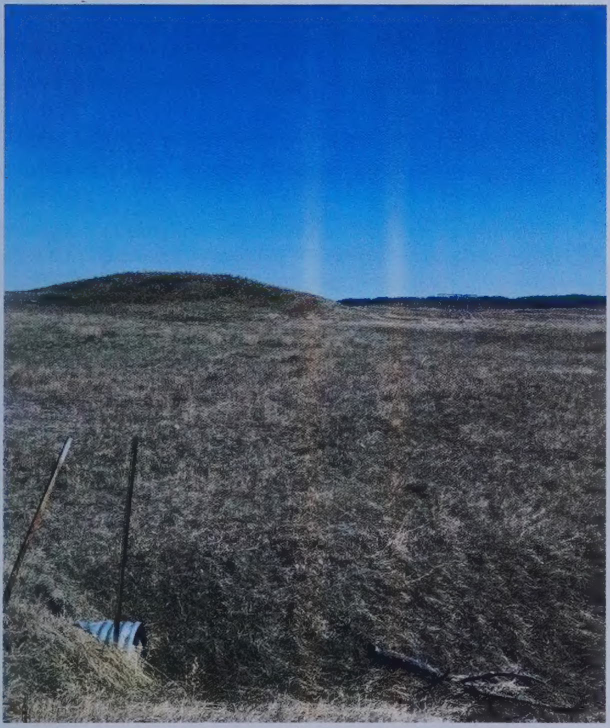
BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
April 9, 2020
Tetra Tech Project No.: 117-8033001.300



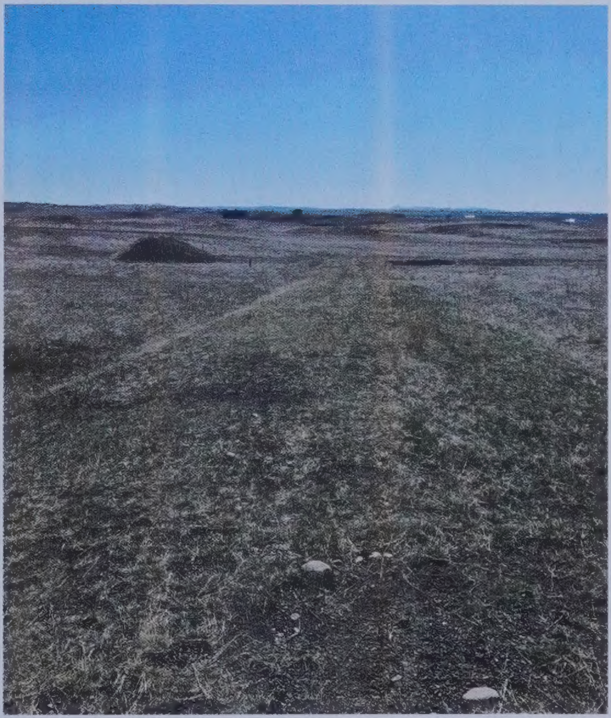
PHOTOGRAPH 1 Looking southwest toward former waste cell.



PHOTOGRAPH 2 Looking southwest from top of former waste cell.



PHOTOGRAPH 3 Looking north from below (south) of former waste cell.



PHOTOGRAPH 4 Looking east from maintenance yard.

(5

Nelsen, Sara

From:	Eder, Michael
Sent:	Friday, April 23, 2021 1:02 PM
To:	DEQ SW Program
Subject:	FW: Emailing: Big Timber Landfill 2021 Post Closure
Attachments:	Big Timber Landfill 2021 Post Closure.pdf

Please log, and route for file.

Closed City of Big Timber Landfill/Post-Closure/Sweet Grass County/#308

Mike

From: Rice, Jeffrey <Jeffrey.Rice@tetratech.com>
Sent: Friday, April 23, 2021 11:13 AM
To: Eder, Michael <Mike.Eder@mt.gov>
Subject: [EXTERNAL] FW: Emailing: Big Timber Landfill 2021 Post Closure

RECEIVED
APR 23 2021
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Mike: Attached is the post closure inspection report for 2021. I would like to visit with you sometime about abandoning their methane points and monitor wells. We still have six years before the 30 year post closure period is completed but I don't anticipate these will ever be necessary and well abandonment costs, while not that expensive, are not going to get any less expensive. Thanks
Jeff

Jeff Rice | Senior Project Manager
Business +1 (406) 248-9161 | Mobile +1 (406) 671-4851 | jeffrey.rice@tetratech.com

Tetra Tech | *Leading with Science®* | **Billings Montana ECA Office**
7100 Commercial Ave., Suite 4, Billings, MT, 59101 | tetratech.com [tetratech.com]

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TETRA TECH

LICENSE # Closed

COUNTY Sweetgrass

FILE CATEGORY IS

ACTIVE BUD CLOSED PENDING

ONE-TIME LANDFARM

FILE IN

Autoclave	GW Reports
Main	Inspections
Closure/PostClosure	Liner/Leachate
[✓ FA]	Meth Control
Closure/PostClosure FA	Meth Monitoring
GW Corr Measures	O & M
GW Monitoring	Run-On/Run-Off

ADD'L DIRECTIONS

Eng, Cost Est

TETRA TECH

RECEIVED

APR 01 2020

DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

April 10, 2020

Mr. Kris Novotny
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: Post-Closure Site Inspection
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 117-8033001.200

Dear Mr. Novotny:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech, Inc. (Tetra Tech) on April 9, 2020 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.1404.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site.

No areas of subsidence were observed. The general appearance of the closed landfill and vegetative cover throughout the site remains in good condition. Some minor revegetation issues were again observed; however, areas previously noted as having sparse vegetation appear to be improving, and these areas are not associated in locations where waste was buried. No rills or gullies were observed which would demonstrate active erosion. Most areas with poor to fair vegetative cover also continue to display a large percentage of surface coarse fragments, which are armoring soils from further wind erosion.

Fencing along the south property boundary remains in good condition and no damaged fencing was observed. The area around the building is continuing to be used for equipment and materials storage for the City of Big Timber.

Tetra Tech
7100 Commercial Avenue Suite 4, Billings, MT 59101
Tel 406.248.9161 Fax 406.248.9282 www.tetratech.com

Post-Closure Site Recommendations

Tetra Tech does not recommend any additional work at this time. For your convenience, we have forwarded a copy of this report to the Montana Department of Environmental Quality (MDEQ). If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech, Inc.

Michael Hatten

Michael Hatten, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

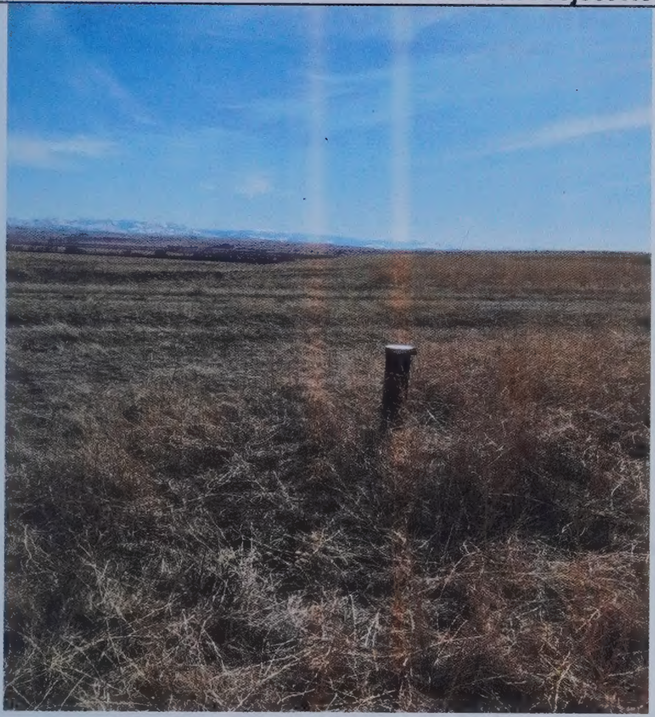
MH/JRR/ba

Attachment: Photographs

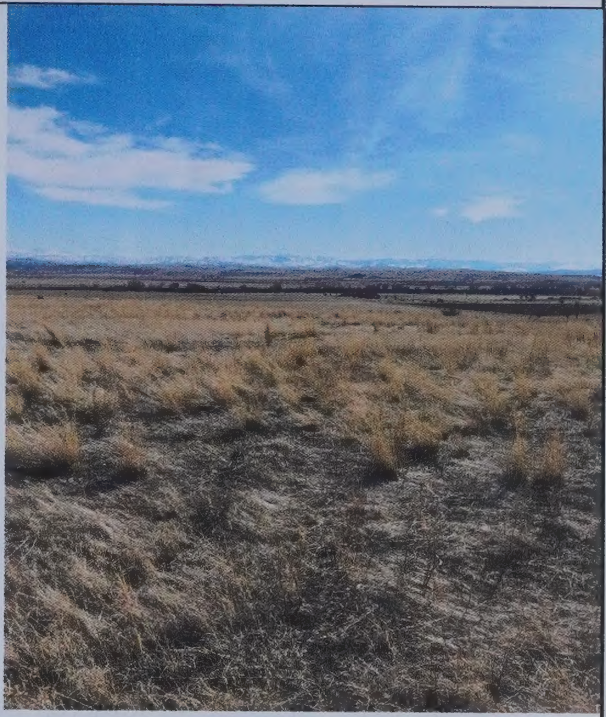
cc: Mike Eder MDEQ, Helena, MT, delivered via email mike.eder@mt.gov

I:\A-G\Big Timber City Of\117-8033001 - Big Timber LF Site Inspection\05-Deliverables\Final\2020 Post Closure\Big Timber Landfill 2020.docx

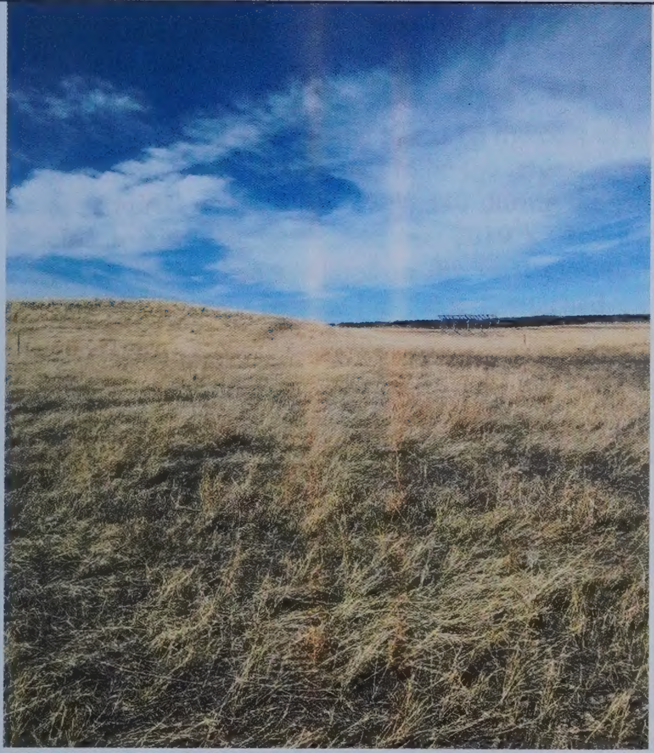
BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
April 9, 2020
Tetra Tech Project No.: 117-8033001.200



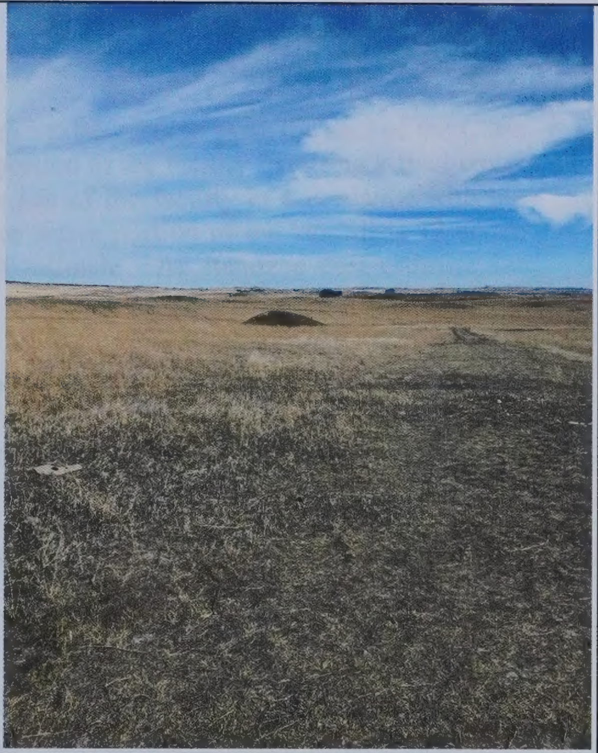
PHOTOGRAPH 1 Looking southwest toward former waste cell.



PHOTOGRAPH 2 Looking south from top of former waste cell.



PHOTOGRAPH 3 Looking north from below (south) of former waste cell.



PHOTOGRAPH 4 Looking east from maintenance yard.

Hydrometrics, Inc.
Consulting Scientists and Engineers

5602 Hesper Rd.
Billings, MT 59106-3236
(406) 656-1172
Fax: (406) 656-8912
www.hydrometrics.com

Danielle Snoke
Buckhorn Waste Services
6312 S Fiddlers Green Circle, Suite 300 E
Greenwood Village, CO 80111

31 March 2020

RE: 2020 Closure and Post-closure Cost Estimates for Oaks Disposal Services (Montana License # 528)

Dear Ms. Snoke:

Hydrometrics, Inc. is pleased to submit written cost estimates to Buckhorn Waste Services, owners of the Oaks Disposal Services Landfill (the landfill), for closure and post-closure activities associated with the landfill for 2020. The cost estimates provided herein were prepared in accordance with ARM 17.50.540(2) and (3).

Closure Costs

Closure costs are estimated based on the cost of hiring a third party to close the area of the Class II landfill that is determined to be the largest active portion in the facility requiring a final cover as required under ARM 17.50.540 during the active life of the facility in accordance with the closure plan (Hydrometrics, Inc. 2019[1]). The current active portion of the landfill is 12 acres, which is the area assumed in the final closure cost estimate. An itemized cost estimate for landfill closure is included in Table 1, attached.

The cost estimate is based on closure by final cover with an alternative evapotranspiration cap consisting of a nominal nine (9) inches of topsoil, 39 inches of subsoil, and a six (6) inch capillary break. Subgrade preparation and other construction costs are included in Table 1. Total closure costs for the current largest active landfill area were estimated to be $422,968. Because the estimate was made in 2019, the current inflation multiplier (1.0110) was applied to update costs for 2020. Closure costs, to the nearest 2020 US dollar, are estimated to be $427,621.

Post-Closure Costs

Post-closure care costs, provided in Table 2 (attached), are based on the landfill's current post-closure plan[1]. Periodic costs related to annual groundwater monitoring, inspections, maintenance, reporting, and administration are assumed for a 30 year post-closure period, as required by 17.50.1404(1). Costs associated with closure of the landfill's leachate collection system, during the post-closure care period, are also summarized in Table 2. Total post-closure costs for the 30-year period were estimated to be $537,432 in 2019. By applying the current inflation multiplier, 2020 post-closure care costs are estimated to be $543,344.

---

[1] Hydrometrics, Inc. 2019. Oaks Disposal Landfill Closure and Post-Closure Plan

The combined total of closure and post closure care costs for 2020 is **$970,965**. These costs are consistent with the landfill's updated closure and post-closure plan[1]. As such, the costs provided herein are of sufficient scope to establish financial assurance requirements for closure and post closure care. Please feel free to contact me by email (rlabbe@hydrometrics.com) or phone (406.490.3168) with any questions.

Sincerely,

Richard Labbe, P.E.
Environmental Engineer

CC: Tim Stepp, Montana Department of Environmental Quality, Solid Waste Management Section (electronic copy)
Jimmy Berry, Buckhorn Waste Services (electronic copy)
Mark Franks, Oaks Disposal Services (electronic copy)

Table 1. Closure Cost Estimate for Oaks Disposal Services Cells 1&2 (12 Acres).

Engineer's Estimate of Probable Construction Costs based on Alternative Final Cover (AFC) design: 6-inch capillary break, 39-inch subsoil, 9-inch topsoil.

Item	Description	Estimated Quantity	Pay unit	Unit Price	Total Price
1	Mobilization/demobilization/bonding/insurance	1	LS	10%	$ 34,956
2	Subgrade preparation	12.0	AC	$ 2,100.00	$ 25,200
3	Construct ET cover				
3.1	Capillary break	9,700	CY	$ 4.00	$ 38,800
3.2	Subsoil	63,000	CY	$ 3.30	$ 207,900
3.3	Topsoil	14,600	CY	$ 3.60	$ 52,560
4	Misc. related grading	1	LS	$ 3,500.00	$ 3,500
5	Seed & mulch	12.0	AC	$ 1,800.00	$ 21,600
		Construction Cost Subtotal			**$ 384,516**
	Contingency	1	LS	10%	$ 38,452
		2019 Total Closure Cost			**$ 422,968**
		***2020 Total Closure Cost**			**$ 427,620**

LS = lump sum

CY = cubic yard

AC = acre

*Total cost = 2019 cost x current inflation multiplier of 1.0110

Table 2. Post-Closure Cost Estimate for Oaks Disposal Services.
Engineer's estimate of probable post-closure care costs. Based on anticipated monitoring and maintenance schedule.

Item	Description	Estimated Quantity	Pay unit	Unit Price	Total Price
1	Groundwater Monitoring	2	LS	$ 2,500	$ 5,000
2	Laboratory Analysis of Groundwater Samples	2	LS	$ 2,500	$ 5,000
3	Reporting	2	LS	$ 1,000	$ 2,000
4	Inspection and Cost Estimate Updates	2	LS	$ 600	$ 1,200
5	Maintenance	1	LS	$ 2,000	$ 2,000
6	Administration and Contingency	10	%	$ 1,520	$ 1,520
		Total Annual Cost			**$ 16,720**
7	Leachate Pond Removal and Reclamation				
7.1	Leachate Disposal (includes trucking and Class I injection)	1,786	BBL	$ 12.00	$ 21,432
7.2	Liner and Leachate Pipe Disposal	80	Ton	$ 60.00	$ 4,800
7.3	Re-grading and contouring	2	AC	$ 3,000.00	$ 6,000
7.4	Seeding and Mulch	2	AC	$ 1,800.00	$ 3,600
		Total 30-Year Cost (2019)			**$ 537,432**
		Total 30-Year Cost (2020)			**$ 543,344**

LS = lump sum

BBL=barrel (42 gallons)

AC= acre

*Total cost = 2019 cost x current inflation multiplier of 1.0110

County Big Timber

Facility & # 308

[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other: ______________________

____

Landfarm
Liner
Methane
O & M
Run-on

Nelsen, Sara

From: Collins, John
Sent: Tuesday, April 23, 2019 10:37 AM
To: DEQ SW Program
Subject: FW: Big Timber Landfill Post closure
Attachments: Big Timber Landfill 2019 Post-Closure.pdf

CLOSED
#303 Sweetgrass

RECEIVED
APR 23 2019
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

From: Rice, Jeffrey [mailto:Jeffrey.Rice@tetratech.com]
Sent: Tuesday, April 23, 2019 8:54 AM
To: mhendrickson@mt.gov; Collins, John <JCollins3@mt.gov>
Subject: Big Timber Landfill Post closure

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Please contact your agency IT staff for more information.

My apologies for sending to both but I was unsure as to who is the regulatory contact for this landfill.
Jeff

Jeff Rice | Senior Project Manager
Direct **(406) 384-0319** | Main **(406) 248-9161** | Fax **(406) 248-9282** |
jeffrey.rice@tetratech.com

Tetra Tech | *Leading with Science®* | Environmental Services Division
7100 Commercial Ave., Suite 4 | Billings, MT 59102 | tetratech.com

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April 22, 2019

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APR 2 3 2019

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Mr. Kris Novotny
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: Post-Closure Site Inspection
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 117-8033001

Dear Mr. Novotny:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech on April 19, 2019 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.1404.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site.

No areas of subsidence were observed. The general appearance of the closed landfill and vegetative cover throughout the site remains in good condition. Some minor revegetation issues were again observed; however, areas previously noted as having sparse vegetation appear to be improving, and these areas are not associated in locations where waste was buried. No rills or gullies were observed which would demonstrate active erosion. Most areas with poor to fair vegetative cover also continue to display a large percentage of surface coarse fragments, which are armoring soils from further wind erosion.

Fencing along the south property boundary has been improved and no damaged fencing was observed. The area around the building is currently being used for equipment and materials storage for the City of Big Timber.

Post-Closure Site Recommendations

Tetra Tech does not recommend any additional work at this time. For your convenience, we have forwarded a copy of this report to the Montana Department of Environmental Quality (MDEQ). If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech, Inc.

Michael Hatten

Michael Hatten, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

MH/JRR/ba

Attachments: Figure
Photographs

cc: Mary L. Hendrickson MDEQ, Helena, MT, delivered via email mhendrickson@mt.gov

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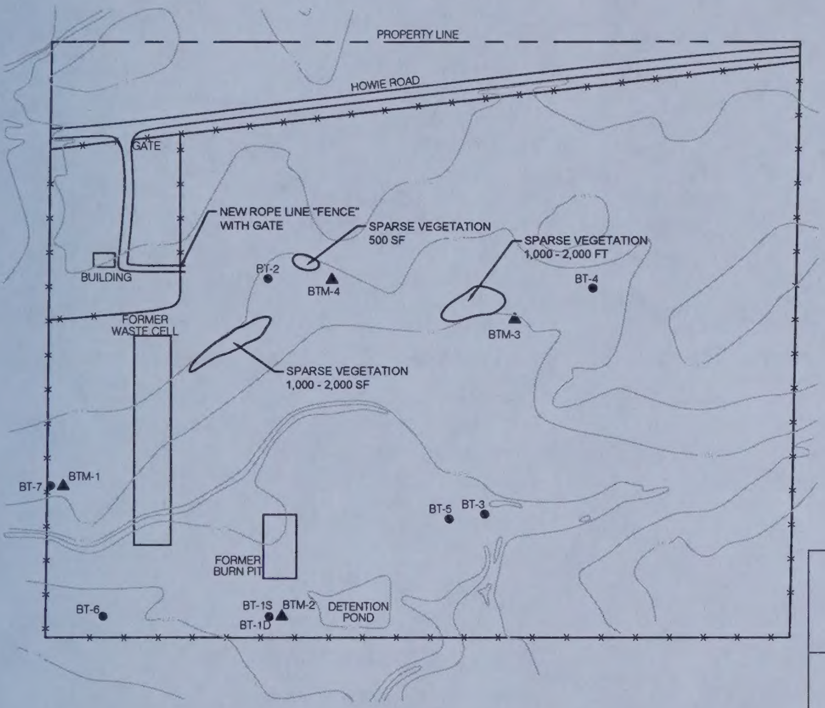


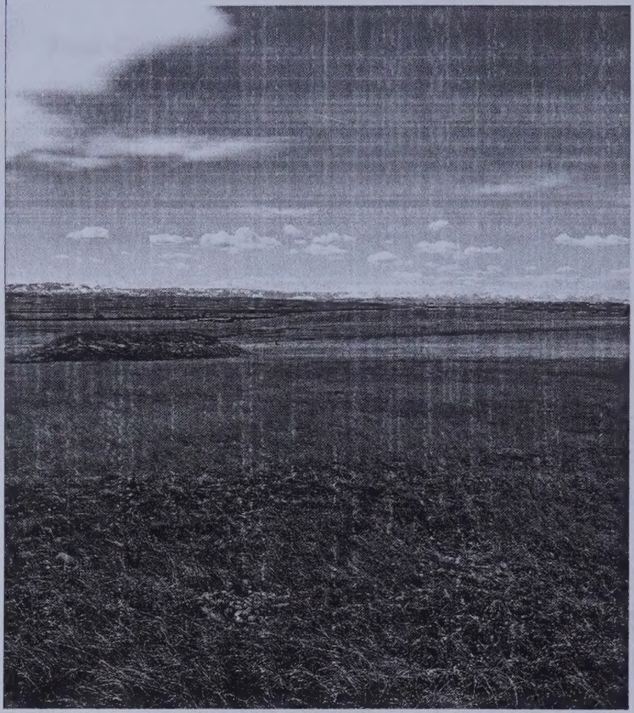
PROPERTY LINE
HOWIE ROAD
GATE
NEW ROPE LINE "FENCE"
WITH GATE
SPARSE VEGETATION
500 SF
SPARSE VEGETATION
1,000 - 2,000 FT
BUILDING
BT-2
BTM-4
BT-4
BTM-3
FORMER
WASTE CELL
SPARSE VEGETATION
1,000 - 2,000 SF
BT-7
BTM-1
BT-5
BT-3
FORMER
BURN PIT
BT-6
BT-1S
BTM-2
BT-1D
DETENTION
POND

LEGEND
BT-4 FORMER MONITORING WELL
BTM-3 FORMER METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURFACE CONTOUR
(CONTOUR INTERVAL 10')
N
0
200
400
APPROXIMATE SCALE IN FEET

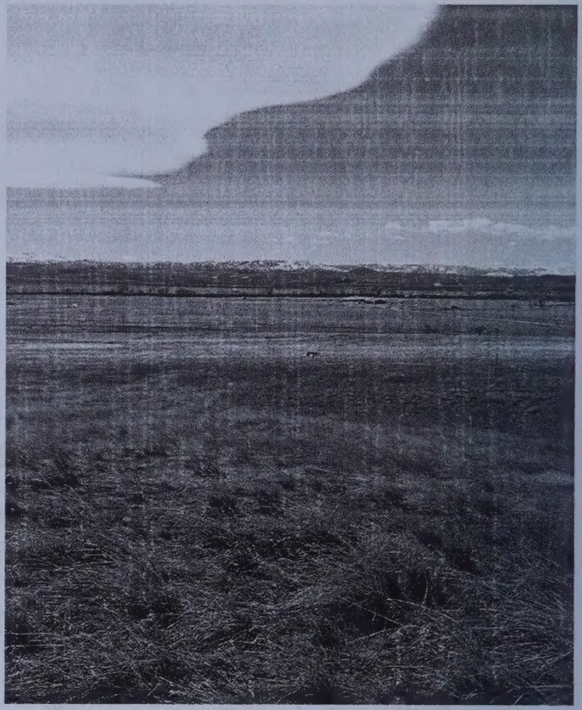
SITE INSPECTION
April 19, 2019
Former Sanitary Landfill
City of Big Timber, Montana

DRAWN:	APPROX. SCALE:	FIGURE NO.
DLL	1"=400'	1
REVIEWED: JR	DATE: 04/22/2019	PROJECT NO. 117-8033001

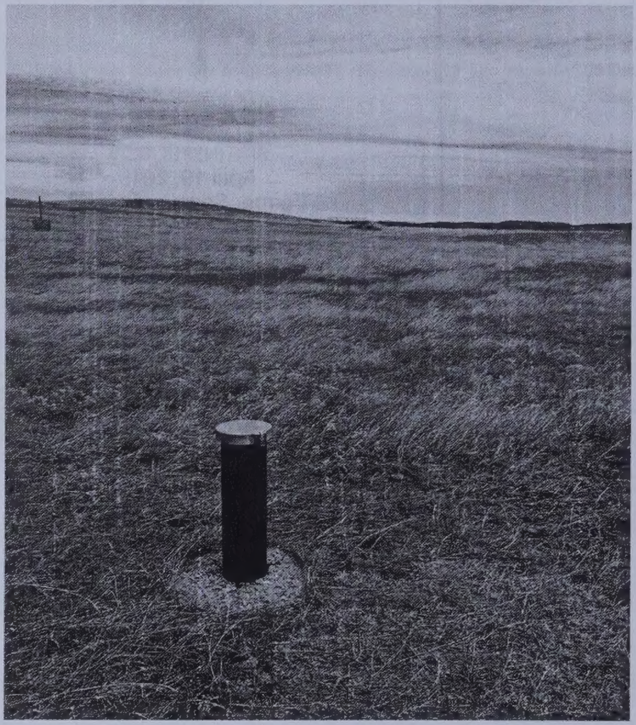
BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
April 19, 2019
Tetra Tech Project No.: 117-8033001



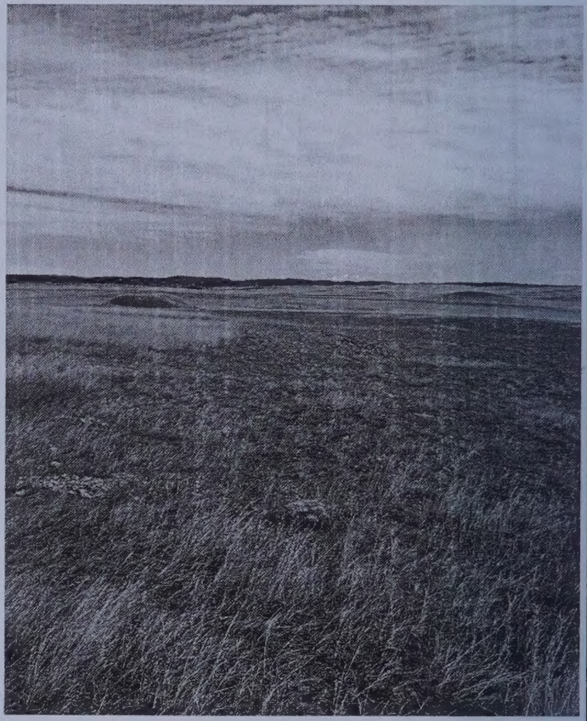
PHOTOGRAPH 1 Looking southwest toward former waste cell.



PHOTOGRAPH 2 Looking south from top of former waste cell.



PHOTOGRAPH 3 Looking north from below (south) of former waste cell.



PHOTOGRAPH 4 Looking east from maintenance yard.

CLOSED

County Sweet Grass

Facility & # Big Timber LF

Closure
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections

Landfarm
Liner
Methane
O & M
Run-on

Other: post-closure

OS 3/17/15

TETRA TECH

BT

RECEIVED

MAR 16 2015

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

March 9, 2015

Mr. Rick Gibby
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: Post-Closure Site Inspection
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 114-551657.100

Dear Mr. Gibby:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech on February 23, 2015 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site.

The general appearance of the closed landfill and vegetative cover throughout the site is good. Some minor issues were again observed; however, areas previously noted as being sparse appear to be slowly re-vegetating. Small bare spots were observed east and south of the former waste cell and burn pit (Figure 1). An approximate 500 square feet area bare spot was observed just northeast of BT-2 (Figure 1). Additionally, a larger area approximately 1,000 to 2,000 square feet was also noted further to the north and east of the former waste cell. The west side of the former burn pit currently has little vegetation established. Minor erosion is visible in this area although no rills or gullies are present which would indicate significant erosion. Most areas with poor vegetative cover have developed a large percentage of surface coarse fragments which are armoring soils from further erosion. All of these areas were observed during the previous inspections.

Tetra Tech
P.O. Box 30615, Billings, MT 59107
618 South 25th Street, Billings, MT 59101
Tel 406.248.9161 Fax 406.248.9282 www.tetratech.com

With the exception of an approximate 150 foot section located near the southwest corner of the property which is worn and loose, the perimeter fence is in place and in good condition. No trash or other materials were observed within the fenced perimeter.

Post-Closure Site Recommendations

Tetra Tech recommends the areas of bare soil over the waste cell be re-seeded and protected from wind erosion according to the Big Timber Landfill Post-Closure Plan to prevent erosion. The areas of sparse vegetation and bare spots over the former burn pit should also have a minimum six inch layer of topsoil re-spread over these sites and be re-seeded with an appropriate seed mix.

For your convenience, we have forwarded a copy of this report to the MDEQ. If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech

Travis Goracke, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

TG/JRR/ba

I:\A-G\City of Big Timber\114-551657 - Big Timber Landfill Consulting\150-Deliverable Reports\2015 Site Inspection\BT Post-Closure Site Inspec 2015.doc

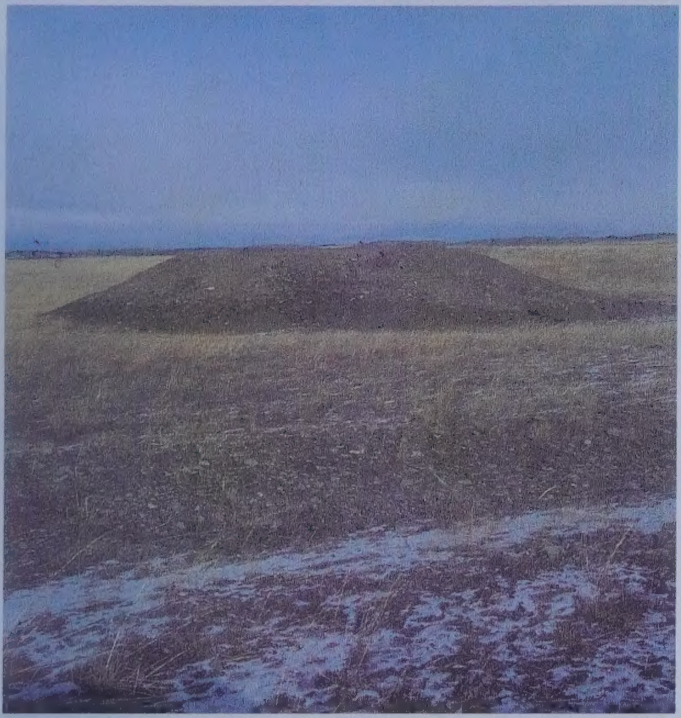
Enclosures:

Figure 1: Site Inspection Base Map
Photographic Log

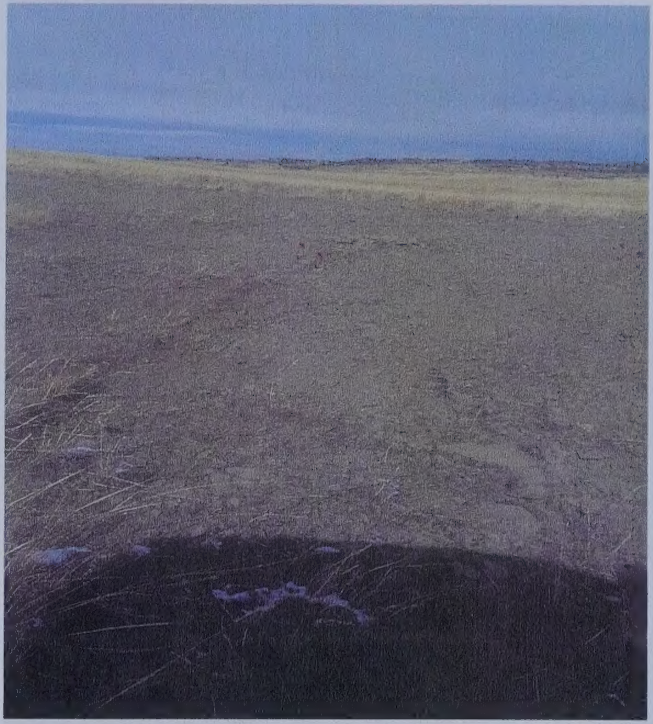
(In two copies)

cc: Gayle McPhearson
Martin Van Oort, MDEQ, Helena, MT, delivered via email mvanoort@mt.gov

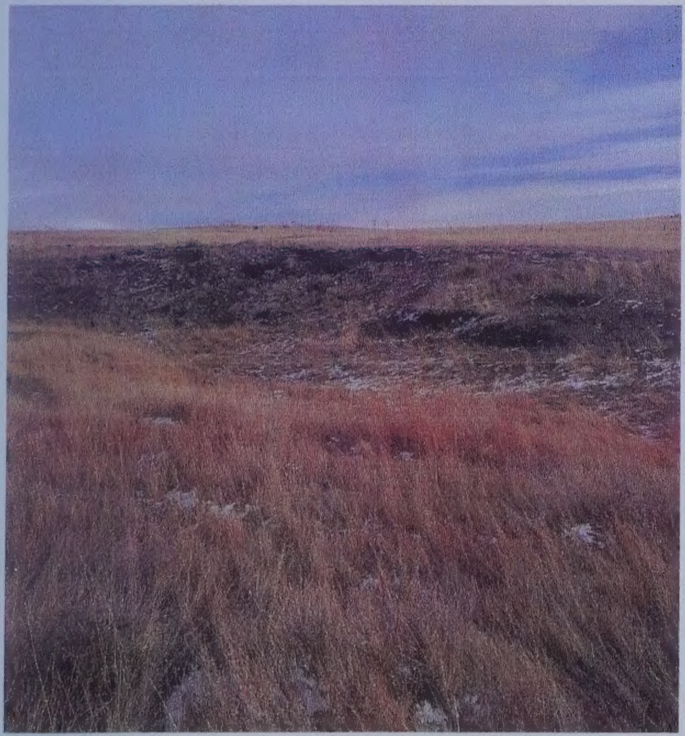
BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
Tetra Tech Project No.: 114-551657



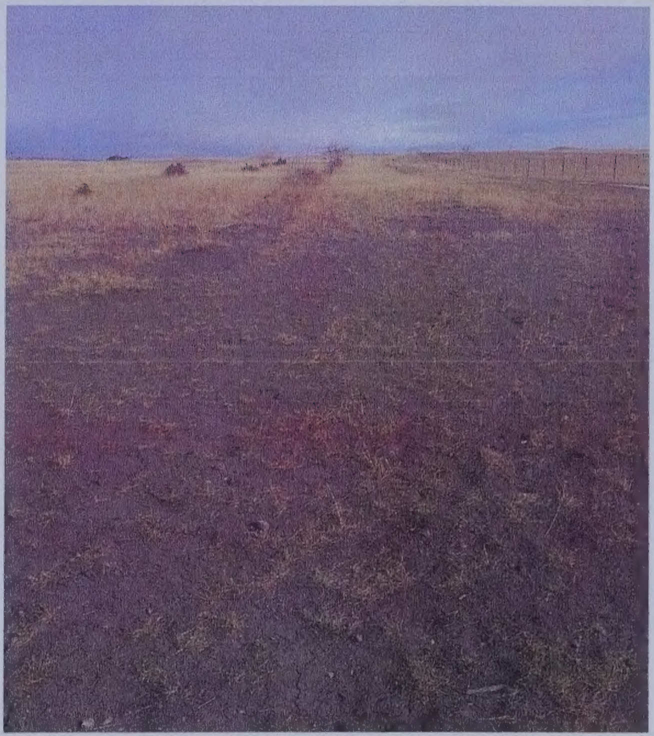
PHOTOGRAPH 1 View looking northeast at 500 SF, sparse vegetation.



PHOTOGRAPH 2 View looking north at 1K – 2k SF, no vegetation.

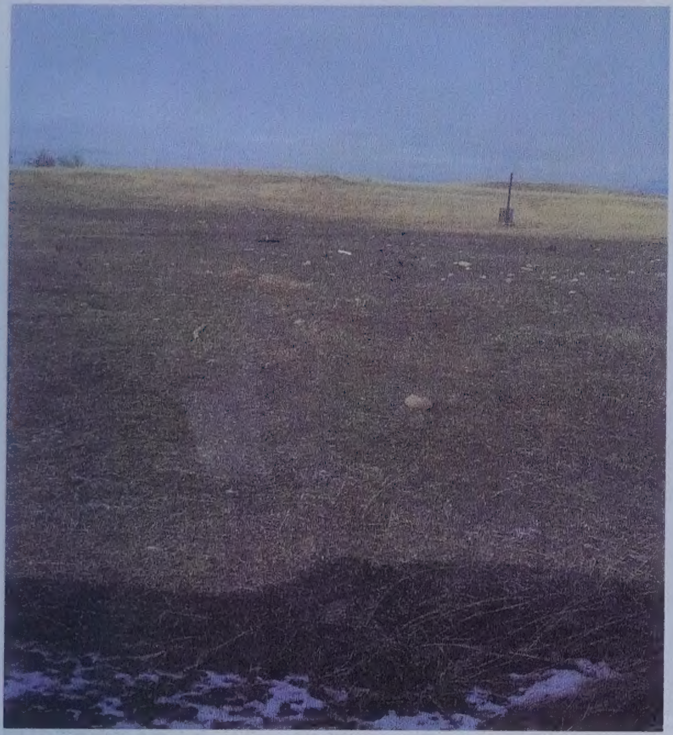


PHOTOGRAPH 3 View looking south at sparse vegetation near the detention pond area.

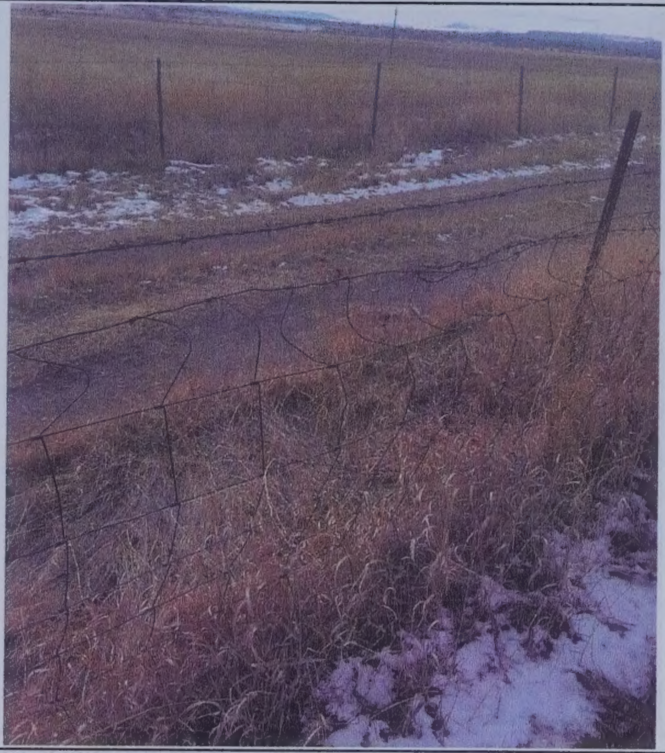


PHOTOGRAPH 4 View looking east at no vegetation near southwest corner site.

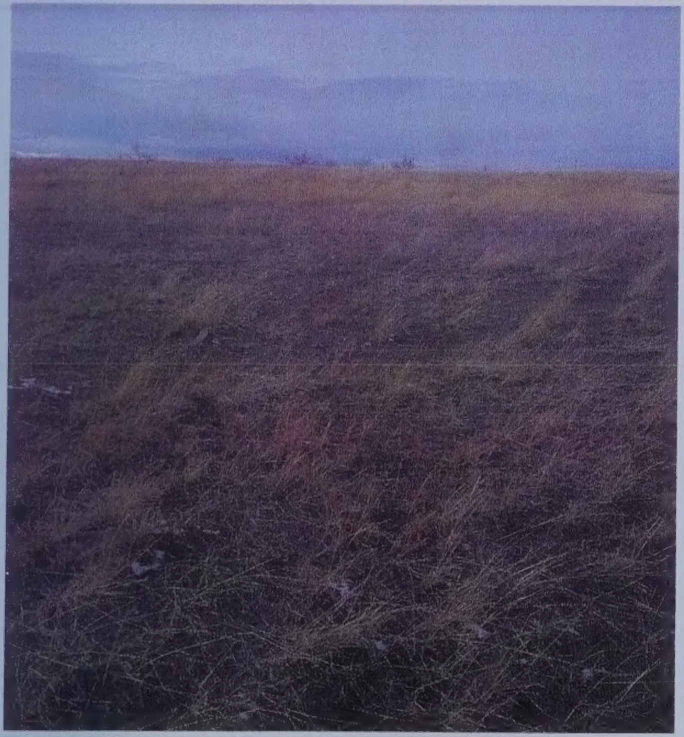
BIG TIMBER SANITARY LANDFILL
POST-CLOSURE SITE INSPECTION
Tetra Tech Project No.: 114-551657



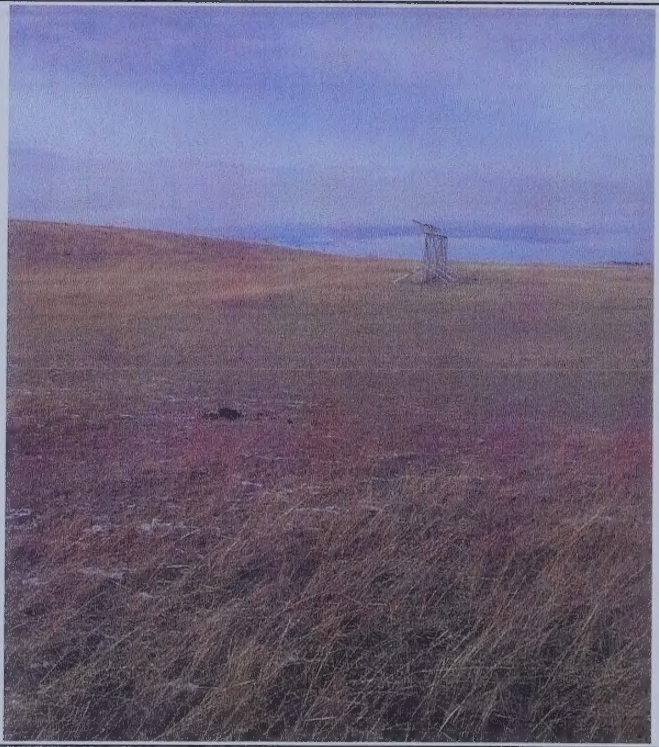
PHOTOGRAPH 5 View looking north at area of sparse vegetation.



PHOTOGRAPH 6 View looking southwest at loosened fence near southwest corner of ste.

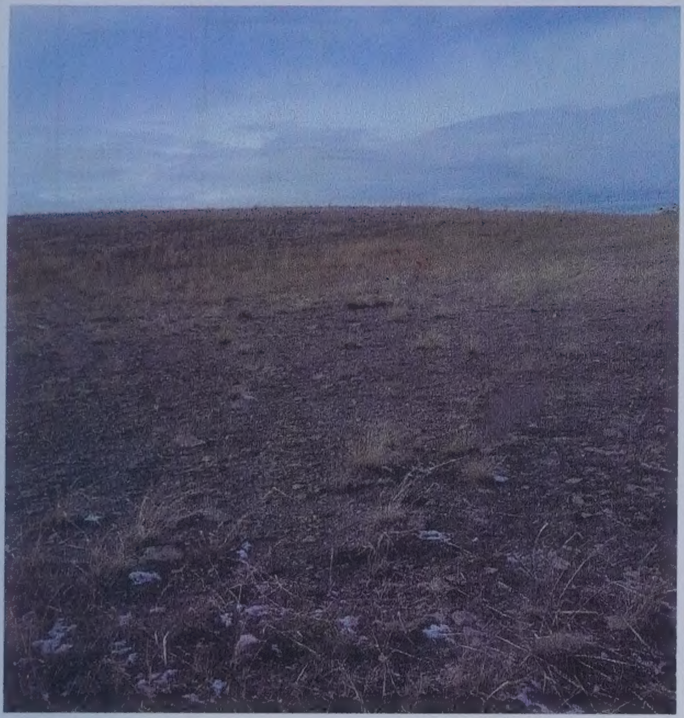


PHOTOGRAPH 7 View looking east at sparse vegetation near southeast corner of former waste cell.

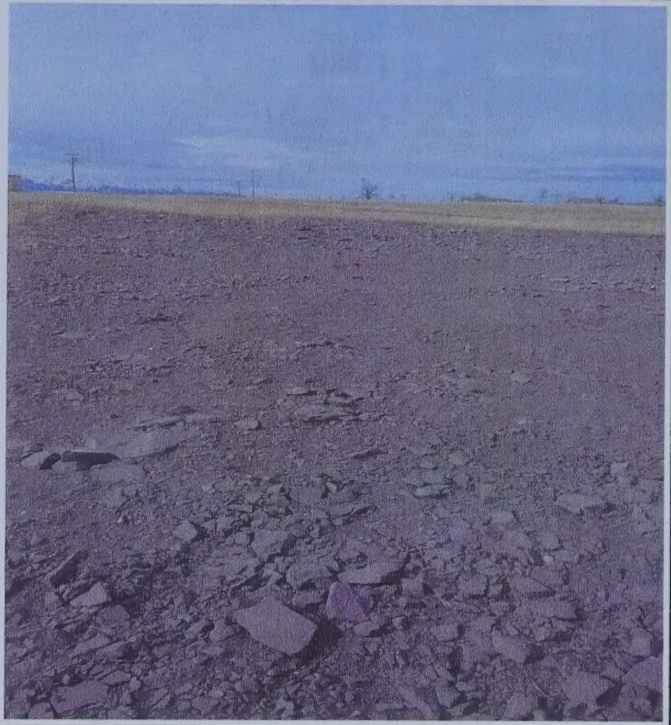


PHOTOGRAPH 8 View looking north at little to no vegetation on the east side of former waste cell.

BIG TIMBER SANITARY LANDFILL
POST-CLOSURE SITE INSPECTION
Tetra Tech Project No.: 114-551657



PHOTOGRAPH 9 View looking northwest at sparse vegetation on east side of former waste cell.



PHOTOGRAPH 10 View looking northwest at no vegetation near northeast corner of former waste cell.

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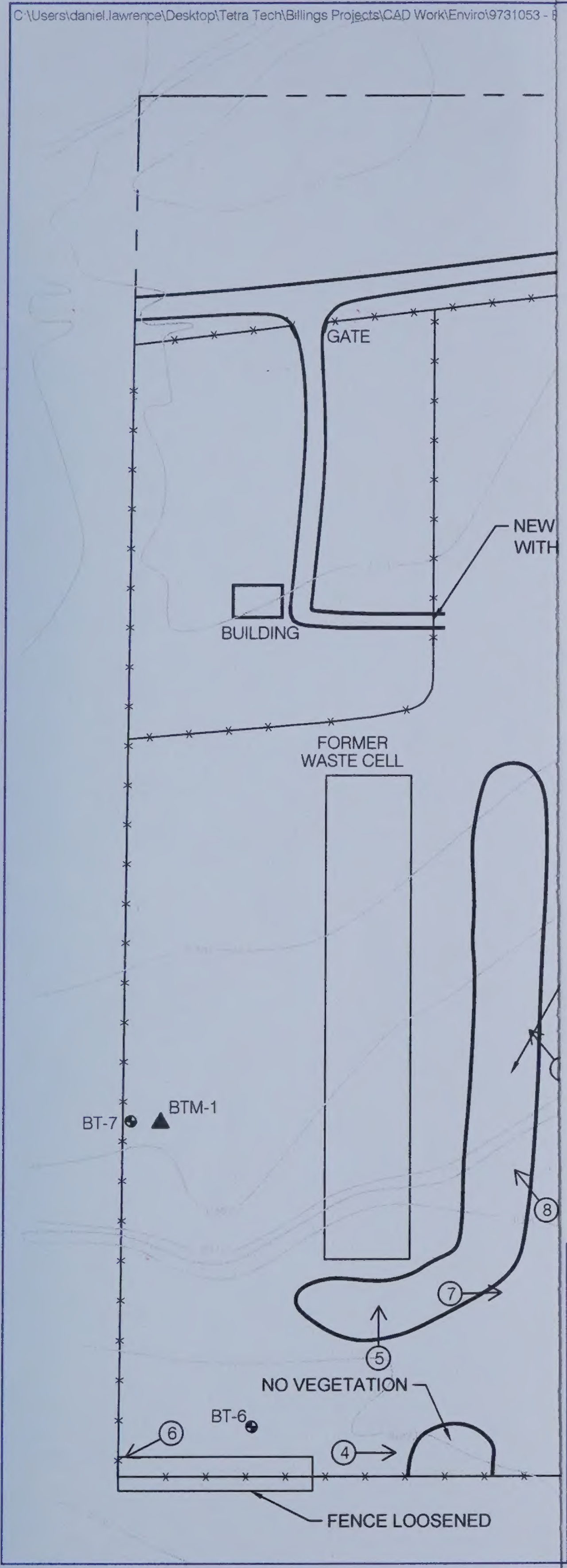
Waste & Underground
Tank Management Bureau


C:\Users\daniel.lawrence\Desktop\Tetra Tech\Billings Projects\CAD Work\Enviro\9731053 -
GATE
NEW
WITH
BUILDING
FORMER WASTE CELL
BT-7
BTM-1
8
7
5
NO VEGETATION
BT-6
6
4
FENCE LOOSENED

LEGEND

BT-4 ⊕ FORMER MONITORING WELL

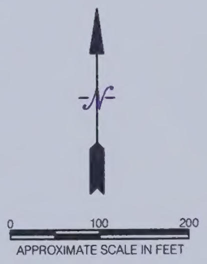
BTM-3 ▲ FORMER METHANE POINTS

—x— FENCE

—-—- PROPERTY BOUNDARY

GROUND SURFACE CONTOUR (CONTOUR INTERVAL 10')

① → PHOTOGRAPH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APPROXIMATE SCALE IN FEET

SITE INSPECTION
February 23, 2015
Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: DLL	APPROX. SCALE: 1"=200'	FIGURE NO. 1
REVIEWED: JRR	DATE: 03/06/2015	PROJECT NO. 114-551657

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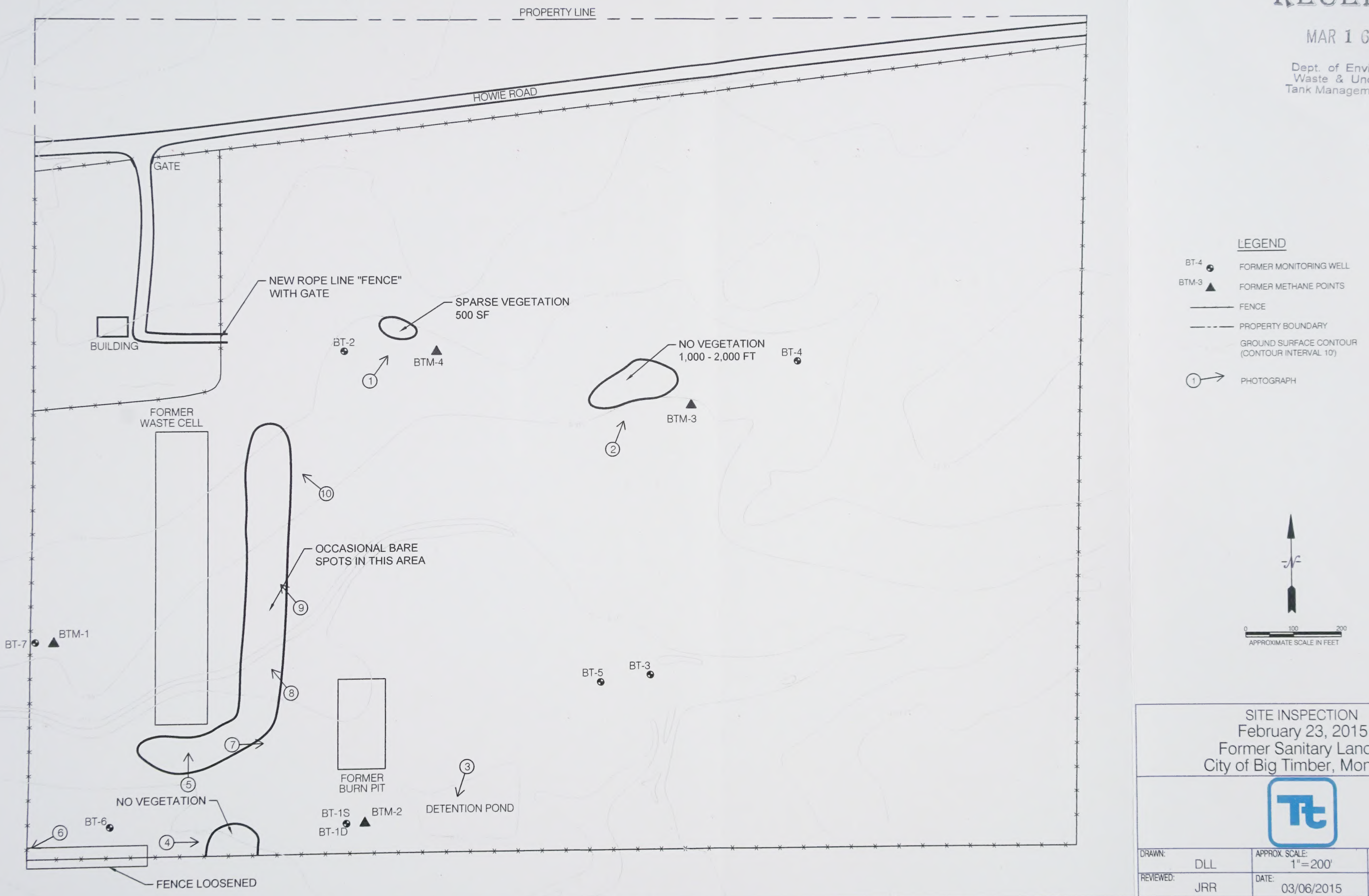
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau


PROPERTY LINE
HOWIE ROAD
GATE
NEW ROPE LINE "FENCE" WITH GATE
SPARSE VEGETATION 500 SF
BUILDING
BT-2
BTM-4
①
NO VEGETATION 1,000 - 2,000 FT
BT-4
BTM-3
②
FORMER WASTE CELL
⑩
OCCASIONAL BARE SPOTS IN THIS AREA
⑨
BT-7
BTM-1
⑧
BT-5
BT-3
⑦
⑤
FORMER BURN PIT
③
DETENTION POND
NO VEGETATION
BT-6
⑥
④
BT-1S
BT-1D
BTM-2
FENCE LOOSENED
LEGEND
BT-4 FORMER MONITORING WELL
BTM-3 FORMER METHANE POINTS
FENCE
PROPERTY BOUNDARY
GROUND SURFACE CONTOUR (CONTOUR INTERVAL 10')
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APPROXIMATE SCALE IN FEET

SITE INSPECTION
February 23, 2015
Former Sanitary Landfill
City of Big Timber, Montana

Tt

DRAWN: DLL	APPROX. SCALE: 1"=200'	FIGURE NO. 1
REVIEWED: JRR	DATE: 03/06/2015	PROJECT NO. 114-551657

CLOSED

County Sweet Grass

Facility & # Big Timber Class II

Closure

Finan Assur

GW Corr Meas

GW Monitoring

GW Reports

Inspections

Landfarm #308

Liner

Methane

O & M

Run-on

Other: Post-closure inspection

OS 3/17/15

TETRA TECH

RECEIVED
MAR 1 6 2015
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

March 9, 2015

Mr. Rick Gibby
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: **Post-Closure Site Inspection**
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 114-551657.100

Dear Mr. Gibby:

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With the exception of an approximate 150 foot section located near the southwest corner of the property which is worn and loose, the perimeter fence is in place and in good condition. No trash or other materials were observed within the fenced perimeter.

Post-Closure Site Recommendations

Tetra Tech recommends the areas of bare soil over the waste cell be re-seeded and protected from wind erosion according to the Big Timber Landfill Post-Closure Plan to prevent erosion. The areas of sparse vegetation and bare spots over the former burn pit should also have a minimum six inch layer of topsoil re-spread over these sites and be re-seeded with an appropriate seed mix.

For your convenience, we have forwarded a copy of this report to the MDEQ. If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Big Timber.

Respectfully Submitted,

Tetra Tech

Travis Goracke, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

TG/JRR/ba

I:\A-G\City of Big Timber\114-551657 - Big Timber Landfill Consulting\150-Deliverable Reports\2015 Site Inspection\BT Post-Closure Site Inspec 2015.doc

Enclosures:

Figure 1: Site Inspection Base Map
Photographic Log

(In two copies)

cc: Gayle McPhearson
Martin Van Oort, MDEQ, Helena, MT, delivered via email mvanoort@mt.gov

BIG TIMBER SANITARY LANDFILL
POST- CLOSURE SITE INSPECTION
Tetra Tech Project No.: 114-551657

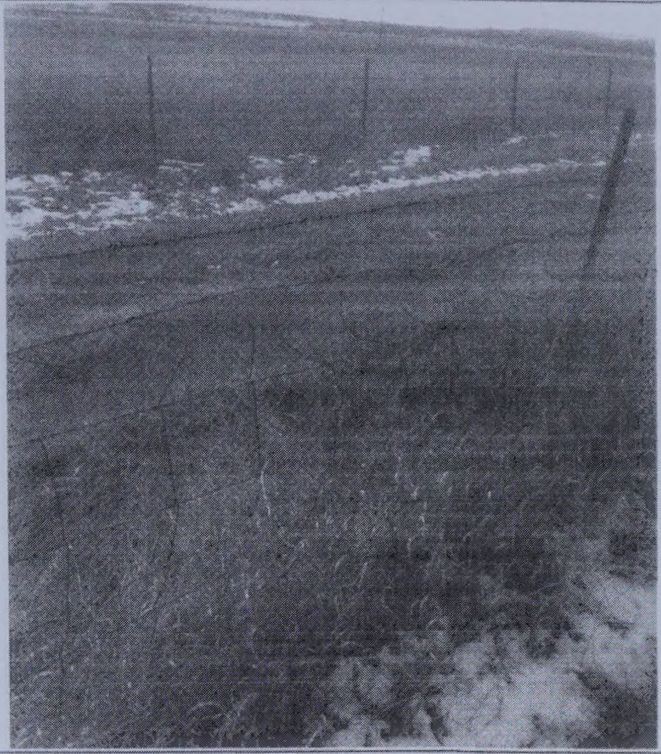
PHOTOGRAPH 1 View looking northeast at 500 SF, sparse vegetation.

PHOTOGRAPH 2 View looking north at 1K – 2k SF, no vegetation.

PHOTOGRAPH 3 View looking south at sparse vegetation near the detention pond area.

PHOTOGRAPH 4 View looking east at no vegetation near southwest corner site.

PHOTOGRAPH 5 View looking north at area of sparse vegetation.



PHOTOGRAPH 6 View looking southwest at loosened fence near southwest corner of ste.

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PHOTOGRAPH 8 View looking north at little to no vegetation on the east side of former waste cell.

BIG TIMBER SANITARY LANDFILL
POST-CLOSURE SITE INSPECTION
Tetra Tech Project No.: 114-551657

PHOTOGRAPH 9 View looking northwest at sparse vegetation on east side of former waste cell.

PHOTOGRAPH 10 View looking northwest at no vegetation near northeast corner of former waste cell.

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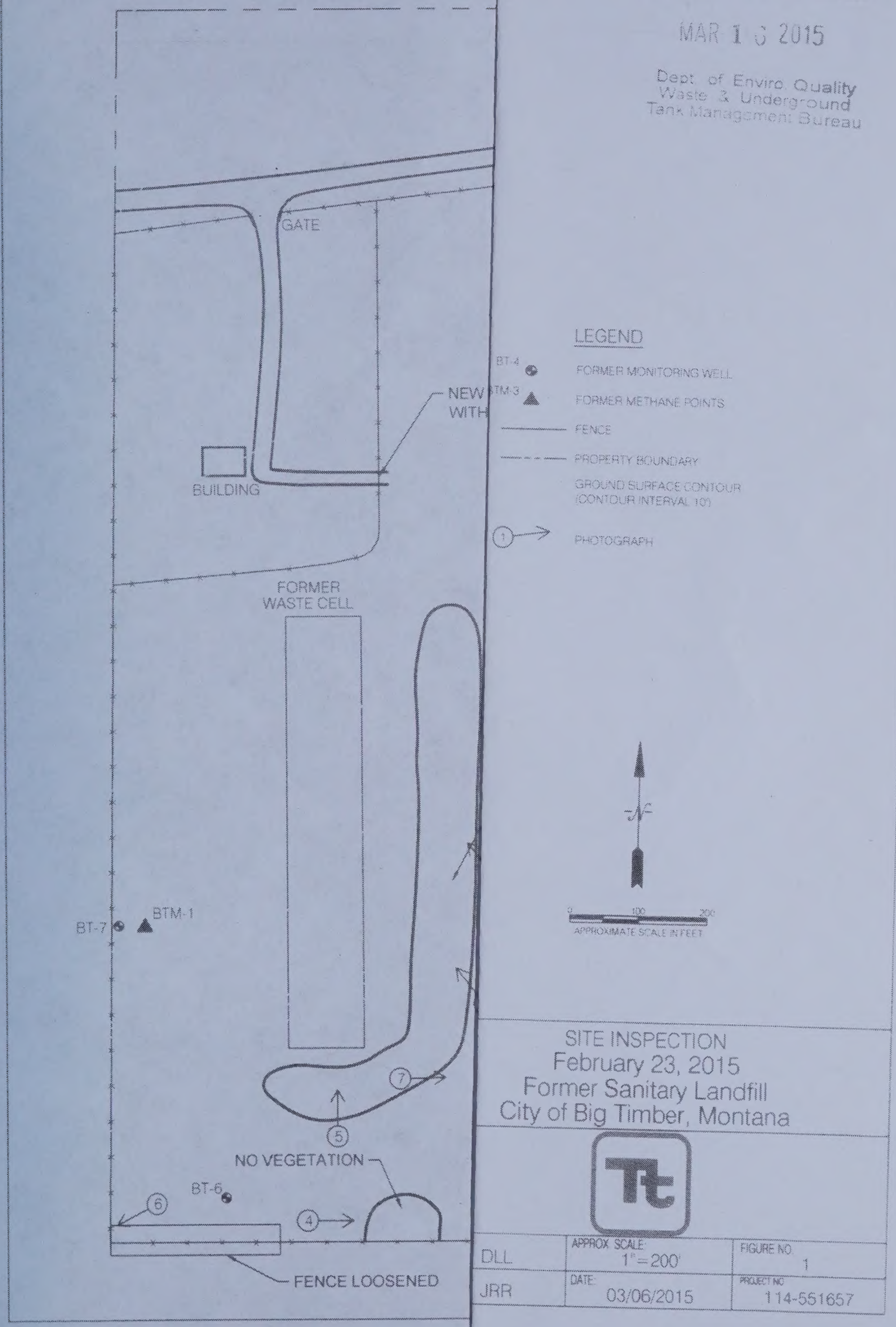
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau


GATE
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FENCE LOOSENED
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LEGEND
BT-4 FORMER MONITORING WELL
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FENCE
PROPERTY BOUNDARY
GROUND SURFACE CONTOUR (CONTOUR INTERVAL 10')
① PHOTOGRAPH
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0 100 200
APPROXIMATE SCALE IN FEET

SITE INSPECTION
February 23, 2015
Former Sanitary Landfill
City of Big Timber, Montana

DLL	APPROX. SCALE: 1" = 200'	FIGURE NO. 1
JRR	DATE: 03/06/2015	PROJECT NO. 114-551657

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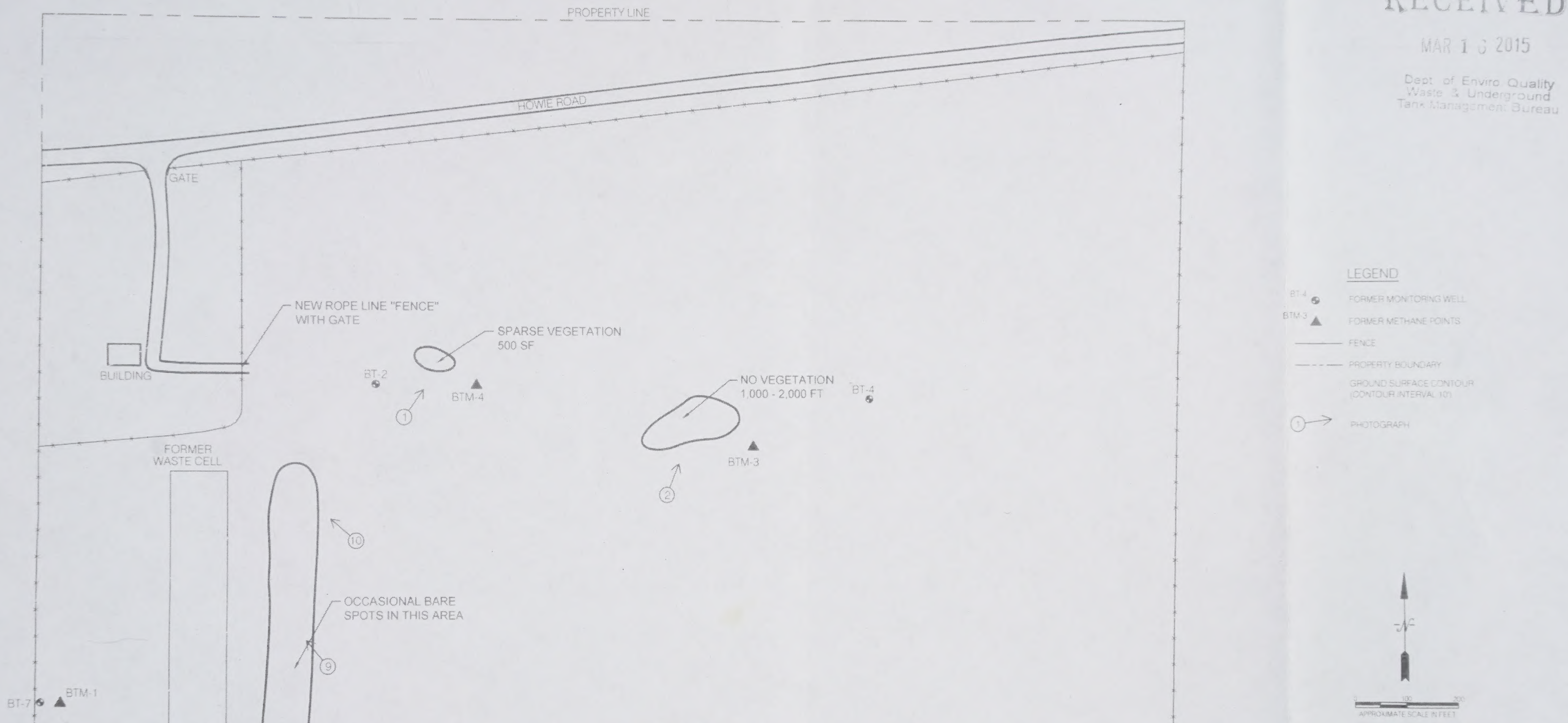
MAR 1 6 2015
Dept of Enviro Quality
Waste & Underground
Tank Management Bureau


PROPERTY LINE
HOWIE ROAD
GATE
NEW ROPE LINE "FENCE"
WITH GATE
BUILDING
SPARSE VEGETATION
500 SF
BT-2
BTM-4
1
NO VEGETATION
1,000 - 2,000 FT
BT-4
BTM-3
2
FORMER
WASTE CELL
10
OCCASIONAL BARE
SPOTS IN THIS AREA
9
BT-7
BTM-1
8
BT-5
BT-3
7
5
FORMER
BURN PIT
3
DETENTION POND
NO VEGETATION
BT-6
6
4
BT-1S
BT-1D
BTM-2
FENCE LOOSENED
LEGEND
BT-4
FORMER MONITORING WELL
BTM-3
FORMER METHANE POINTS
FENCE
PROPERTY BOUNDARY
GROUND SURFACE CONTOUR
(CONTOUR INTERVAL 10')
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PHOTOGRAPH
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200
APPROXIMATE SCALE IN FEET

SITE INSPECTION
February 23, 2015
Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: DLL	APPROX SCALE: 1" = 200'	FIGURE NO. 1
REVIEWED: JRR	DATE: 03/06/2015	PROJECT NO 114-551657

CLOSED

County Sweet Grass

Facility & # Big Timber #308

Closure
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections

Landfarm
Liner
Methane
O & M
Run-on

Other: post-closure

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MAR 2 8 2014

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

March 26, 2014

Mr. Rick Gibby
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: **Post-Closure Site Inspection**
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 1159731053A.100

Dear Mr. Gibby:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech on March 17, 2014 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 2008. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531.

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Based on a recent site inspection by Mr. John Collins and Ms. Mary Louise Hendrickson on August 29, 2013 no further action is required. For your convenience, we have forwarded a copy of this report to the MDEQ. If you have questions concerning the work conducted for

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P.O. Box 30615, Billings, MT 59107
618 South 25th Street, Billings, MT 59101
Tel 406.248.9161 Fax 406.248.9282 www.tetratech.com

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Respectfully Submitted,

Tetra Tech

Travis Goracke, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

TG/JRR/ba

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(In two copies)

cc: Gayle McPhearson
Tim Stepp, MDEQ, Helena, MT, delivered via email: Tstepp@mt.gov

TETRA TECH

March 26, 2014

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MAR 27 2014

DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

Mr. Rick Gibby
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

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Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 1159731053A.100

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Project Engineer

Jeff R. Rice
Environmental Group Manager

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cc: Gayle McPhearson
Tim Stepp, MDEQ, Helena, MT, delivered via email: Tstepp@mt.gov

#308 04/08/09 mfm

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APR - 8 2009

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

March 27, 2009

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City of Big Timber
P.O. Box 416
Big Timber, MT 59011

SUBJECT: **Post-Closure Site Inspection**
Former Big Timber Sanitary Landfill, Big Timber, Montana
Tetra Tech Project No. 1159731053.100

Dear Mr. Gibby:

This letter summarizes the Post-Closure Site Inspection conducted by Tetra Tech on March 3, 2009 at the former Big Timber Sanitary Landfill near Big Timber, Montana (Figure 1). These activities were conducted in general accordance with the *Amended Final Post-Closure Care Plan, Big Timber Sanitary Landfill,* dated March 17, 2009. The post-closure site inspection monitoring partially satisfies the solid waste management requirements of Administrative Rules of Montana (ARM) 17.50.531.

Post-Closure Site Inspection

The post-closure site inspection included documentation of the integrity and effectiveness of the cover materials for the closed landfill cell and burn pit at the former landfill. This investigation included observations for potential subsidence, erosion, condition of vegetative cover (i.e., vegetation density, cover, bare spots, etc.), appearance of the vegetative cover, condition of the perimeter fence and overall general appearance of the former landfill site.

The general appearance of the landfill and vegetation cover throughout the site is good with some poor re-vegetation observed around the former waste cell and burn pit (Figure 2). Two bare spots were observed on the east side of the waste cell approximately 200 square feet in size. Additionally, smaller areas of sparse vegetation were also visible on the south end of the former waste cell cover materials. With the exception of a small portion near the southwest corner of the property, the perimeter fence is in place and in good condition. No significant subsidence was observed on the site.

The west side of the former burn pit has no re-growth currently established. Minor erosion is visible in this area although no rills or gullies are present which would indicate severe erosion. No trash or other materials were observed within the fenced perimeter.

Post-Closure Site Recommendations

Tetra Tech recommends the areas of bare soil over the waste cell be re-seeded according to the Big Timber Landfill Post-Closure Plan (Maxim Technologies, Inc., 1998) to prevent further erosion. The areas of sparse vegetation and bare spots over the former burn pit should have a minimum six inch layer of topsoil re-spread over these sites and be re-seeded with an appropriate seed mix.

We have included a copy of our field notes for your file (Appendix A). If you have questions concerning the work conducted for the site, please call us at (406) 248-9161. We appreciate the opportunity to provide environmental consulting services to the City of Billings.

Respectfully Submitted,

Tetra Tech

Steve Weisenberger, P.E.
Project Engineer

Jeff R. Rice
Environmental Group Manager

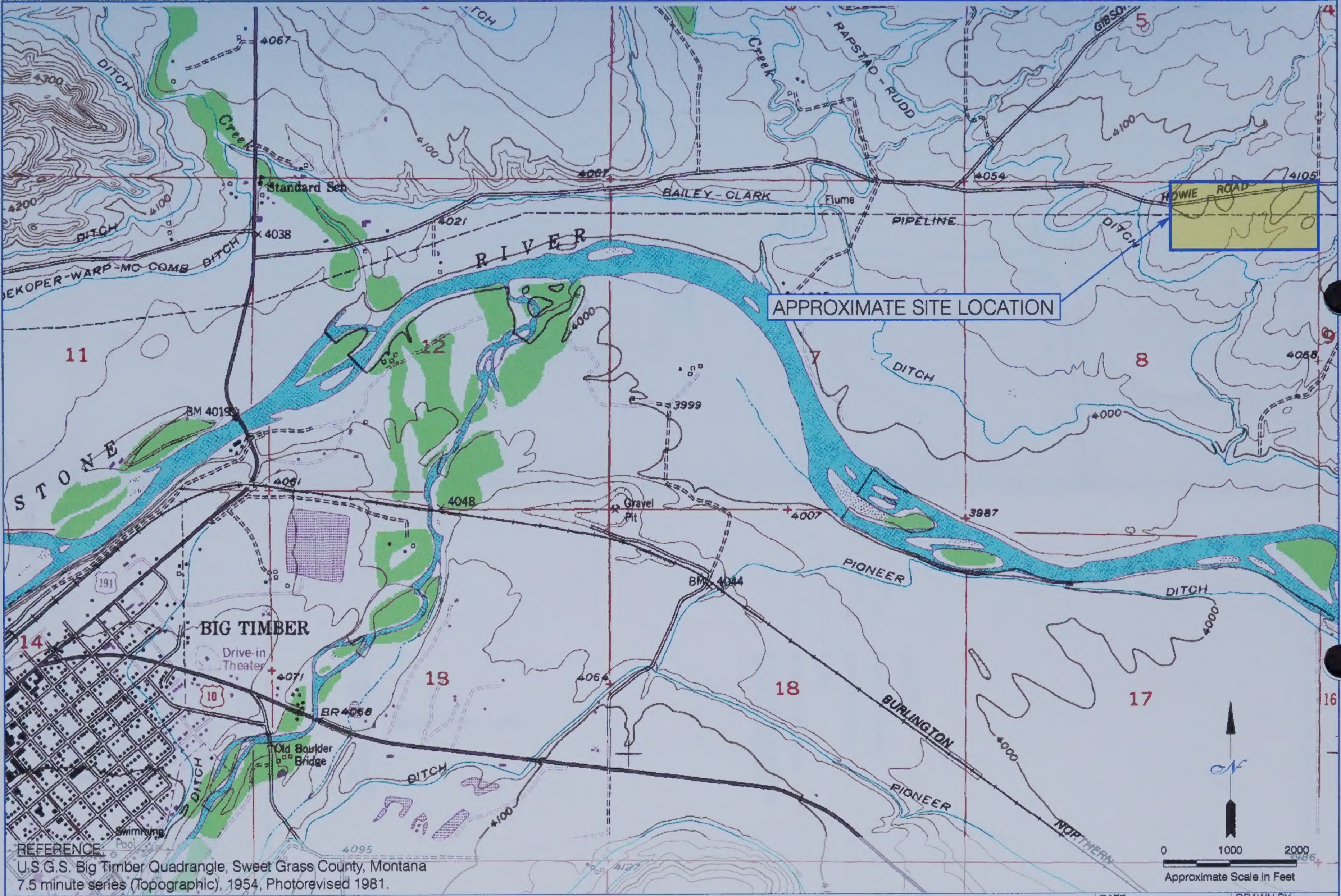
JRR\ba

n\Typing\Env-fac\9731053\City of BT Post-Closure Site Inspection 2009

Enclosures:
Figures
Attachment:A: Post-Closure Field Notes

cc: MDEQ

FIGURES

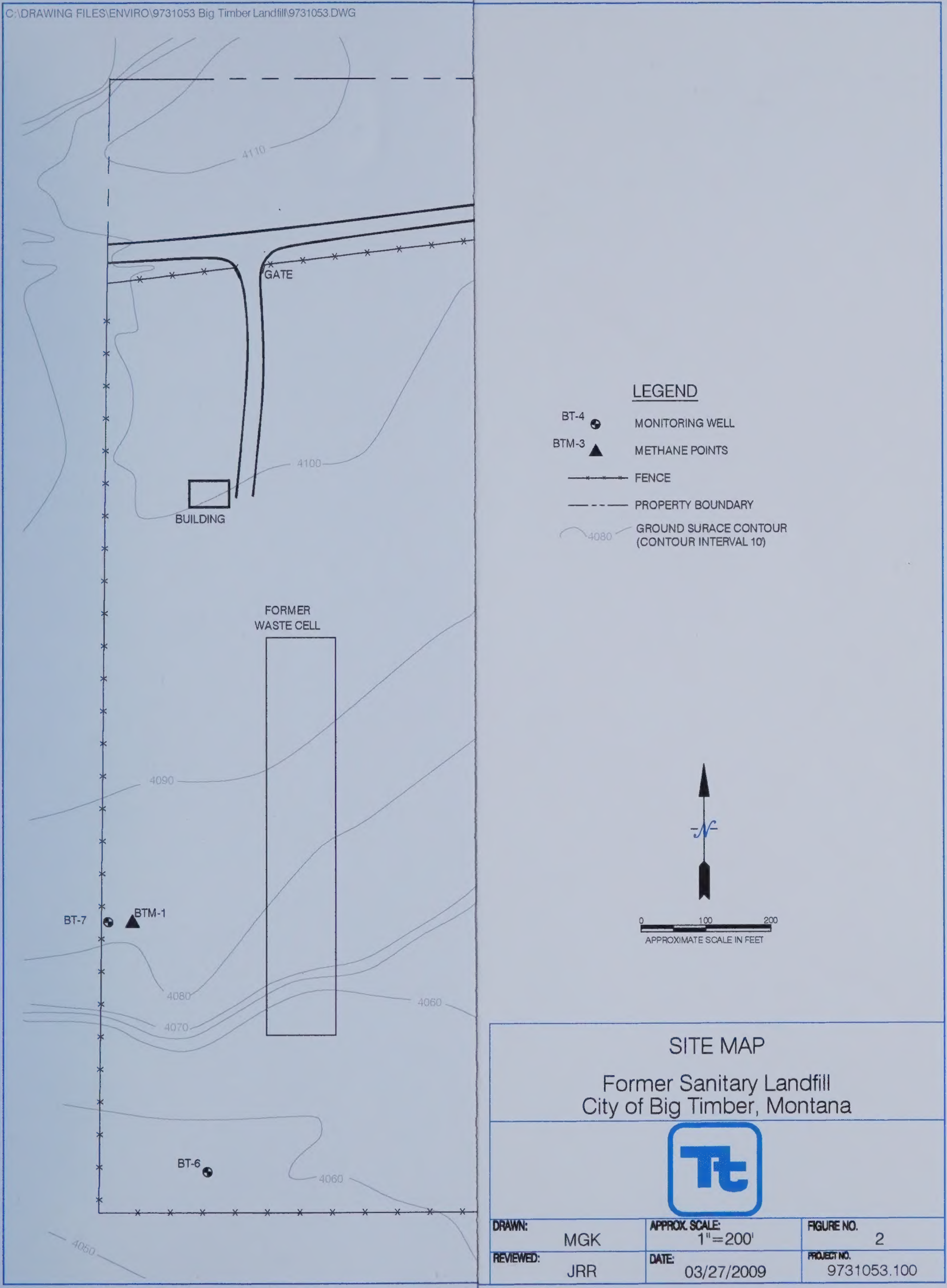

APPROXIMATE SITE LOCATION
HOWIE ROAD
BAILEY - CLARK
PIPELINE
Flume
DITCH
RIVER
STONE
DEKOPER-WARP-MC COMB DITCH
RAPSTAD - RUDD
GIBSON
Creek
Standard Sch
BIG TIMBER
Drive-in Theater
Gravel Pit
Old Boulder Bridge
Swimming Pool
BM 4019
BM 4044
BR 4068
PIONEER
DITCH
BURLINGTON
NORTHERN
4067
4038
4021
4054
4105
4061
4048
3999
4007
3987
4071
4064
4068
4000
4100
4200
4300
4095
4127
5
8
9
7
11
12
13
14
16
17
18
191
10
0
1000
2000
Approximate Scale in Feet
N

REFERENCE:
U.S.G.S. Big Timber Quadrangle, Sweet Grass County, Montana
7.5 minute series (Topographic), 1954, Photorevised 1981.

SITE LOCATION MAP

Former City of Big Timber Sanitary Landfill
Sweet Grass County, Montana

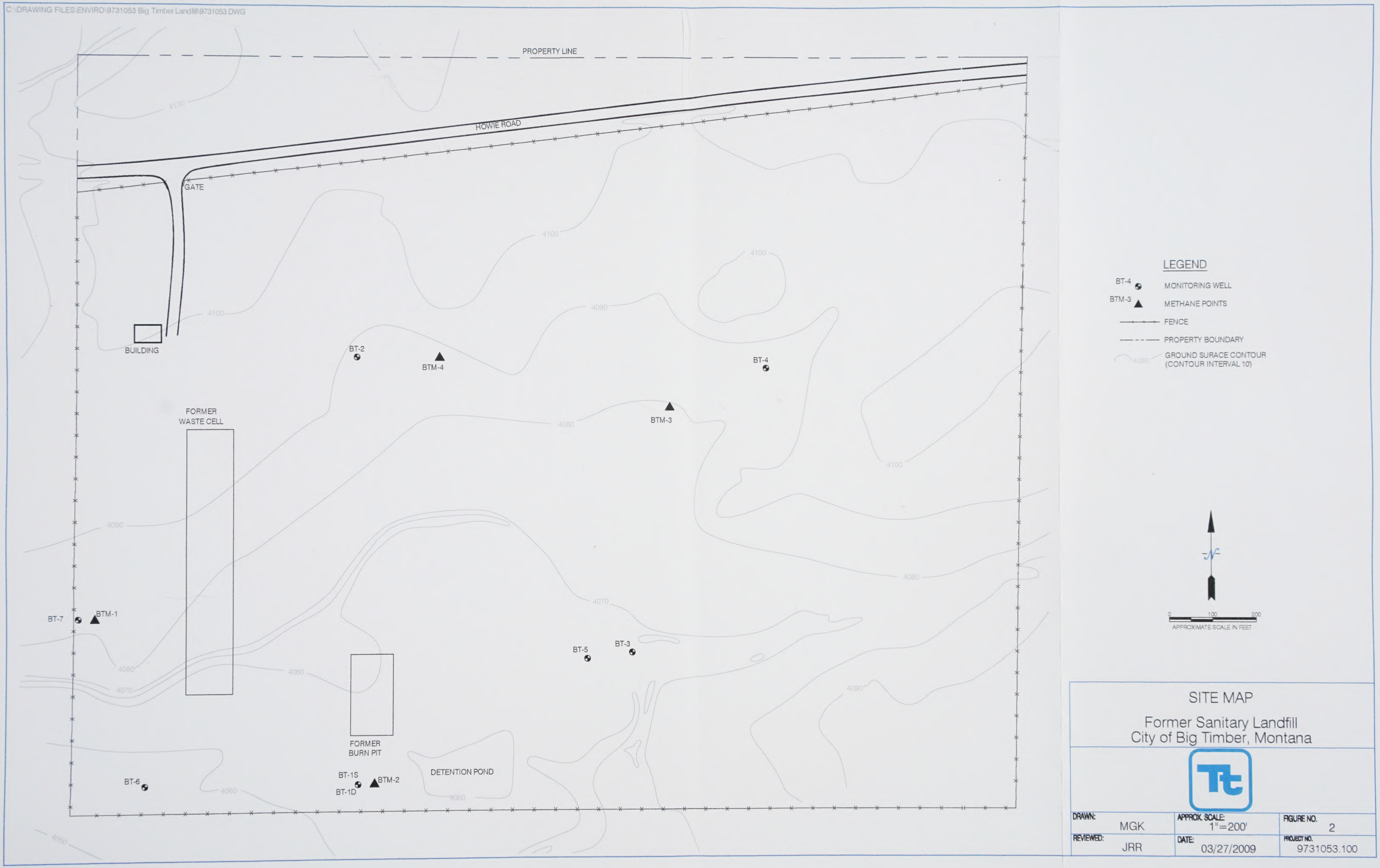
DATE: 03/27/2009	DRAWN BY: MGK
REVIEWED: JRR	APPROX. SCALE: 1"=2000'
PROJ. NO.: 9731053.100	FIGURE NO.: 1


C:\DRAWING FILES\ENVIRO\9731053 Big Timber Landfill\9731053.DWG
4110
GATE
4100
BUILDING
FORMER WASTE CELL
4090
BT-7
BTM-1
4080
4070
4060
BT-6
4060
4050
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURACE CONTOUR (CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE MAP

Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: MGK	**APPROX. SCALE:** 1"=200'	**FIGURE NO.** 2
REVIEWED: JRR	**DATE:** 03/27/2009	**PROJECT NO.** 9731053.100


C:\DRAWING FILES\ENVIRO\9731053 Big Timber Landfill\9731053.DWG
PROPERTY LINE
HOWIE ROAD
GATE
BUILDING
FORMER WASTE CELL
FORMER BURN PIT
DETENTION POND
BT-1S
BT-1D
BT-2
BT-3
BT-4
BT-5
BT-6
BT-7
BTM-1
BTM-2
BTM-3
BTM-4
4100
4090
4080
4070
4060
4050
LEGEND
BT-4 MONITORING WELL
BTM-3 METHANE POINTS
FENCE
PROPERTY BOUNDARY
4080 GROUND SURACE CONTOUR (CONTOUR INTERVAL 10')
N
0
100
200
APPROXIMATE SCALE IN FEET

SITE MAP

Former Sanitary Landfill
City of Big Timber, Montana

DRAWN: MGK	APPROX. SCALE: 1"=200'	FIGURE NO. 2
REVIEWED: JRR	DATE: 03/27/2009	PROJECT NO. 9731053.100

ATTACHMENT A

Post-Closure Field Notes

TETRA TECH

REPORT OF: Daily

Time: 8:00 [✓ AM] PM to 4:00 AM [✓ PM] 8 Total Hours Mileage: ~160 Total Round Trip

To: Jeff Rice

Job No.: 9731053 Date: 3-3-09

Daily Report No.: Sheet 1 of 1

Invoice No.:

Project: Big Timber Landfill

Ryan Sparhawk and myself left the office first thing Tuesday morning and mobilized to the site. When there I performed my inspection which included observation of potential subsidence, erosion, condition of vegetative cover, appearance of vegetative cover, condition of the perimeter fence and the overall appearance of the site. The condition of the site was generally the same as when inspected previously with the exception of a small stretch of damaged fence noted at the southwest corner of the property. When my inspection was done, I helped prepare the paperwork and bottles for Ryan. Left the site around 3:00 pm

Copies:

Field Observer:

Approved By:

City of Big Timber *City letterhead*
P.O. Box 416
Big Timber, Montana 59011

Phone
Clerk: 406-932-5610
Treasurer: 406-932-5611

Tim Stepp
Solid Waste Program
Montana Department of Environmental Quality
PO Box 200901
Helena, Montana 59620-0901

RE: Big Timber Landfill Post-Closure (License #308)

Dear Tim,

As you know the new council has had to update itself as to its responsibilities regarding post-closure monitoring. We apologize for the delay in monitoring and want to inform you that on February 19, 2007 we obtained a quote form Tetra-Tech (formerly Maxim Technologies) to provide the requested monitoring.

The City requested that Great West Engineering, the City's engineer, look over the recent correspondence with the DEQ and Tetra-Tech to provide a recommendation. On March 20, the engineer indicated that the monitoring was required and that costs were reasonable. It is now the City's intent to move forward on conducting this monitoring as soon as possible.

We also note that the deadline for monitoring compliance was April 1, 2007. We request that you consider our recent efforts and permit us an extension of approximately 6 months for the completion of monitoring.

Thank you for your consideration. Please call if you need anything.

Sincerely,

Diana Taylor
The City of Big Timber
Diana Taylor, Mayor

RECEIVED
MAR 23 2007
DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

County SWEET GRASS CO. #308
Facility & # CITY OF BIG TIMBER CLASS II
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other: ____________________

Landfarm
Liner
Methane
O & M
Run - On

PC

4-5

MAXIM
TECHNOLOGIES INC

303 Irene Street
Helena, Montana 59601
P.O. Box 4699
Helena, Montana 59604

(406)443-5210
Fax: (406)449-3729

April 28, 1998

Mr. Pat Crowley
Waste Management Section
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RECEIVED
APR 2 9 1998
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

RE: Closure Plan for Big Timber Landfill

Dear Mr. Crowley:

Enclosed please find two copies of the closure plan Maxim Technologies has prepared for the Big Timber landfill. The City of Big Timber has reviewed the closure plan and requested that we forward the plan to MDEQ for review and approval.

The design for the closure plan includes an alternative landfill cover which uses evapotranspiration to reduce infiltration into the buried refuse to a level similar to that for the prescriptive landfill cover described in ARM 17.50.530. The cover design should also be less susceptible to long term damage due to dessication and freezing as compared to the prescriptive landfill cover.

Please contact us if you should have any questions during your reveiw.

Best Regards,

Brian R. Grant, P.E.
Geological Engineer

Dave Hage
for David C. Tyler
Project Manager

encl. closure plan (2-copies)

cc. Vincent Kunda, Chairman, City of Big Timber, P.O. Box 416, Big Timber MT 59011
Earl Tufte, Morrison-Maierle, 2020 Grand Ave., Billings, MT 59102

Austin Research Engineers • Chen-Northern • Empire Soils Investigations
Kansas City Testing • Southwestern Laboratories • Twin City Testing

City of Big Timber

P.O. Box 416
Big Timber, Montana 59011

Clerk (406) 932-5610
Treasurer (406) 932-5611

RECEIVED
FEB 12 2001
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

February 8, 2001

Mr. Tim Stepp
Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

RE: City of Big Timber Landfill

Dear Mr. Stepp:

This letter is a follow up to your letter of November 13, 2000 to the City of Big Timber. We have also communicated a number of times since then by telephone. On behalf of the City, I would like to thank you for the helpful and courteous manner in which you have responded to questions.

Your letter of November 13th identified the need for a deed notation regarding the landfill site. In subsequent discussions we agreed that this could be restricted to the disturbed area. The attached document is filed with the Sweet Grass County Clerk and Recorder. Generally it covers an area about 200 feet beyond the perimeter of the fill area.

Please advise either the City of Big Timber or myself on other requirements that must be met before closure certification is provided. While the City wants to comply with necessary requirements, they also want to complete the process.

Sincerely,

Erl Tufte, P.E.
City Engineer

cc: City of Big Timber

NOTICE

NOW COMES the CITY OF BIG TIMBER, a MONTANA MUNICIPAL CORPORATION, P.O. Box 416, Big Timber, MT 59011, and gives notice under the provisions of ARM17.50.530 (1) (i) (ii) regarding the following described real property owned by said CITY:

> A tract of land located in the northeast quarter of Section 8, Township 1 North, Range 15 East P.M.M., Sweet Grass County, Montana, being more particularly described as follows:
>
> The south 990 feet of the west 500 feet of Tract A, Certificate of Survey No. 117632, Sweet Grass County, Montana, as filed 4-9-90 in the office of the Clerk and Recorder of Sweet Grass County, Montana.

This notice is given to conform to the above ARM17.50.530 (1) (i) (ii) by giving notice to the public and particularly to any potential purchaser of the above described real property that said real property was used as a landfill by the City of Big Timber, that the property has been closed as a landfill, and that its use is restricted under the provisions of ARM17.50.531 (1) (c) (iii), as follows:

> "Post-closure use of the property must not disturb the integrity of the final cover, liner, or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in these rules. The department may approve any other disturbance if the owner or operator demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste. will not increase the potential threat to human health or the environment."

This notice should be used in reference to the Warranty Deed to the City of Big Timber, dated February 14, 1991, and recorded in Book 67, Page 752, in the office of the Clerk and Recorder of Sweet Grass County, Montana.

Dated this the 31 day of January, 2001.

CITY OF BIG TIMBER

BY: Gary Smart
Gary Smart, Mayor

ATTEST

BY:
Lois Stevens, Clerk

SWORN TO AND SUBSCRIBED BEFORE ME
This 31st day of January, 2001.

Notary Public, State of Montana
My Commission Expires 6/26/02

Montana Department of
ENVIRONMENTAL QUALITY

Marc Racicot, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • E-mail: www.deq.state.mt.us

1737

MAILED
11/15/00

November 13, 2000

Mr. Ron Thomas
P.O. Box 416
Big Timber, MT 59011

RE: INSPECTION REPORT—CLOSURE STATUS APPROVAL
BIG TIMBER CLASS II LANDFILL (Lic. #308)

Dear Mr. Thomas:

On December 6, 1999, I inspected your facility, according to ARM § 17.50.530(1)(h)(ii), for compliance with the approved Closure Plan. The Field Observation Form is enclosed.

In accordance with ARM § 17.50.530(1)(b), the Program has approved an alternative water-balance cover for the site. The minimum specified performance is within the range of hydraulic conductivity for the type of sandy loam soils used on site for final cover borrow.

Order-of-magnitude variations in the actual performance of the alternative cover (e.g. caused by limited ET layer thickness) may be tolerated, because of conservative design factors, the semiarid climate, and significant soil water evaporation from severe winds typical for this area.

Six inches of topsoil was not provided, yet the seed mix planted this year is beginning to establish a thin stand of grasses on the loamy cover; some compost could be spread over the site, if necessary, to increase soil moisture retention in the future.

Certification of closure completion by a registered professional engineer is not on file, however, this inspection and letter provides Program verification according to ARM § 17.50.530(1)(h)(ii). Your interim closure status continues until the deed notation required by ARM § 17.50.530(1)(i) is filed with this office, when final closure will be approved.

We appreciate your cooperation. If you have any questions or comments, please contact me at the Permitting and Compliance Division, Community Services Bureau, Waste Management Section: Telephone (406) 444-4725, email *tstepp@state.mt.us* or FAX (406) 444-1374.

Sincerely,

Tim Stepp

Tim Stepp
Geological/Geophysical Engineer

Encl: Copy of On-Site Observation Form, Inspection Report, photos (3)
Cc: Rod Fink, Sweet Grass Co. Sanitarian
File: **Lic. # 308** Sweet Grass Co/Big Timber class II/Inspections…/Closure
Path: \\DEQ_MET_PRI\SHR\UNITSHAR\CSB\S w s\closure\bigtimber_closure1299.doc

Department of Environmental Quality
Permitting and Compliance Division
Community Services Bureau
Waste Management Section
P.O. Box 200901
Helena, Montana 59620-0901
(406) 444-4400

Date: 12/6/99
Time: 4pm

SOLID WASTE MANAGEMENT SYSTEM CLOSURE INSPECTION FORM

Facility Name: Big Timber Class II License Number: 308

Owner/Operator: City of Big Timber Phone:

Address: City: STATE:

General Site Location: 1mi N of town, 3mi E on Howie Rd

Landfill Representative(s): Ron Thomas

DEQ Inspector: Tim Stepp

AREAS OF REGULATORY COMPLIANCE

	Compliance Issue:		Yes	No
(1)	Minimum 18-Inch Infiltration Layer on All Wastes	Ron says WBC ≥ 4 ft total	X	
(2)	Infiltration Layer Meets Minimum Permeability Standards	WBC	N	A
(3)	Minimum 6-Inch Erosion Layer on All Wastes			X
(4)	Ron-On/Run-Off Controlled		X	
(5)	Site Revegetated Within 1 Year of Placement of Final Cover	thin, but taking		X
(6)	Access to Site Controlled		X	
(7)	Written Closure Plan on File and Approved		X	
(8)	Notice of Intent to Close on File		X	
(9)	Closure Activities 30 Days After Final Acceptance of Waste		X	
(10)	Closure Activities Complete 180 Days After Beginning of Closure	extensions	X	
(11)	Certification by Registered Engineer On File	provided by DEQ		X
(12)	Based on Inspection, DEQ Considers Site Closed		X	
(13)	Record of Notation on Deed in Operating Record			
(14)	Other			

NOTES: A water-balance cover is approved for this site — it must provide performance equivalent to 1×10^{-5} cm/sec hyd conductivity.

This inspection is providing DEQ certification of closure.

No topsoil was provided, however, native grasses beginning to take this first year. Broadcast more seed. Could spread some compost, if necessary, at later time.

Time Left Site: 4:45 am/[✓ pm]

Stepp

INITIALS S DATE 11/6/00

SOLID WASTE OUTGOING CORRESPONDENCE ROUTE SLIP

☐ **NEW APPLICATION** — Initial / Date
Mike D.
HAC
Christy
Rick T.
Jon D./ Other

☐ **NEW LICENSE** — Initial / Date
Mike D.
HAC
Karen
Christy
Rick T. / Other

☐ **HEALTH OFFICER CARD** — Initial / Date
Mike D.
Karen
Christy

☐ **INSPECTIONS** — Initial / Date
Pat C.
HAC
Karen
Rick T.

☐ **INTERIM CLOSURES** — Initial / Date
Mike D.
HAC
Karen
Christy
Rick T./ Other

☒ **CLOSURES** — Initial / Date
Mike D. 11/9/00
HAC
~~Karen~~ ok
~~Christy~~ Pat C.
Rick T./ Other 11/09/00
KT 11-14-00

☐ **CHANGE IN LICENSE FOR FEE STATUS** — Initial / Date
Mike D.
HAC
Christy

☐ **COMPLAINTS** — Initial / Date
Pat C.
HAC
Karen

☐ **GROUND WATER** — Initial / Date
HAC
Pat C

☐ **GENERAL CORRESPONDENCE** — Initial / Date
Pat C./ Mike D.
HAC
Rick T.
Jon D./ Other

☐ **MISCELLANEOUS** — Initial / Date

FILE
Path

#308
Sweet Grass

Montana Department of
ENVIRONMENTAL QUALITY **MEMO**

TO: CLOSURE FILE - BIG TIMBER CLASS II LANDFILL (#308)

FROM: Tim Stepp

DATE: November 13, 2000

SUBJECT: **APPROVAL OF WATER-BALANCE-COVER (WBC) CLOSURE**

In accordance with ARM § 17.50.530(1)(b), the Program approved an alternative WBC for the site. Because the landfill is unlined, the alternative cover must at least provide a barrier performance equivalent to an 18-in. infiltration layer of maximum hydraulic conductivity equal to 1x10E-5 cm/sec.

A WBC minimizes percolation of vadose water by ensuring sufficient thickness to provide enough water holding capacity (inches per inch of soil) to offset infiltration through evapotranspiration (ET). ET performance depends on climate and plant rooting depth.

At the first-order level of sensitivity, the minimum specified performance standard is within the range of saturated hydraulic conductivity for the type of sandy loam soils (Unified Soil Classification System) used on site for final cover borrow. The USCS soil type of the borrow material was determined by size classification, however, no measurements of porosity, permeability, or hydraulic conductivity were provided for the samples. Estimates of water holding capacity and percolation are determined in the lab through soil drainage tests to obtain the soil water retention curve for each sample. Such tests were not performed.

The models used USCS standard parameters to indicate more than adequate performance. Conservative initial conditions for the HELP model calculations provided both cover and refuse at field capacity, thus, the standard thickness (3-ft final plus intermediate) sandy-loam cover built for the site probably provides adequate water-storage capacity even during the first 2-3 years required to introduce a healthy stand of native grasses.

Order-of-magnitude variations in the actual performance of the alternative cover (e.g. caused by limited ET layer thickness) may be tolerated, because of the conservative design factors, the semiarid climate, and significant soil water evaporation from severe winds typical for this area. Thus, the lack of lab measurements may not critically affect the compliance.

INITIALS [redacted] DATE 11/14/00

SOLID WASTE OUTGOING CORRESPONDENCE ROUTE SLIP

☐ **NEW APPLICATION** — **Initial / Date**
Mike D.
HAC
Christy
Rick T.
Jon D./ Other

☐ **NEW LICENSE** — **Initial / Date**
Mike D.
HAC
Karen
Christy
Rick T. / Other

☐ **HEALTH OFFICER CARD** — **Initial / Date**
Mike D.
Karen
Christy

☐ **INSPECTIONS** — **Initial / Date**
Pat C.
HAC
Karen
Rick T.

☐ **INTERIM CLOSURES** — **Initial / Date**
Mike D.
HAC
Karen
Christy
Rick T./ Other

☐ **CLOSURES** — **Initial / Date**
Mike D.
HAC
Karen
Christy
Rick T./ Other

☐ **CHANGE IN LICENSE FOR FEE STATUS** — **Initial / Date**
Mike D.
HAC
Christy

☐ **COMPLAINTS** — **Initial / Date**
Pat C.
HAC
Karen

☐ **GROUND WATER** — **Initial / Date**
HAC
Pat C

☐ **GENERAL CORRESPONDENCE** — **Initial / Date**
Pat C./ Mike D.
HAC
Rick T.
Jon D./ Other

☒ **MISCELLANEOUS** Memo: — **Initial / Date**
Mike D.
Rick T. — 11-21-00

FILE
Path — Closure - Big Timber

City of Big Timber
P.O. Box 416
Big Timber, Montana 59011

Clerk (406) 932-5610
Treasurer (406) 932-5611

July 22, 1999

Mr. Pat Crowley
Montana Department of Environmental Quality
Permitting and Compliance Division, Waste Management Section
P.O. Box 200901
Helena, MT 59620-0901

RE: May 1999 Groundwater Monitoring Report
Big Timber Sanitary Landfill, Big Timber, Montana

Dear Pat:

Enclosed please find a copy of the referenced monitoring report for the Big Timber landfill. No inorganic parameters were detected above regulatory standards and volatile organic compounds were not detected during this monitoring.

Since monitoring began at the facility in October 1994, inorganic parameters have been below background values or regulatory standards. Volatile organic compounds have been below detection levels during this period. Therefore, in accordance with your correspondence addressed to Mr. Erl Tufte of Morrison-Maierle dated September 5, 1997, it is our intention to reduce the frequency of groundwater monitoring at the site from a semi-annual schedule to an annual schedule. The next monitoring event is scheduled for April 2000. Please notify us if this is not acceptable.

We are near the point where you could make the site inspection that you suggested on the landfill. You did comment, however, that you would rather see it when the grass has grown. The hot, dry weather has slowed vegetation growth so we are recommending that your site visit be delayed until late August or September. Also, if you have any other thoughts on steps we should be taking please let Ron Thomas or Erl Tufte know.

If you have any questions regarding this reports, please contact us.

Sincerely,

Gary Smart

Gary Smart, Mayor
City of Big Timber

cc: Erl Tufte, MMI

RECEIVED
JUL 30 1999
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

County Sweet Grass
Facility & # Big Timber #308

[✓ Closure]
Finan Assur
GW Corr Meas
[✓ GW Monitoring]
GW Reports
Inspections
Other: ______

Landfarm
Liner
Methane
O & M
Run - On

File
Big Timber
Closure

OK –
Called Erl
1/27/99
P Crowley

Bigt-ltr.7

FAX to Pat Crowley, DEQ Solid Waste Bureau, and Brian Grant, Maxim Technologies (1-25-99):

Ron Thomas and I are proposing the following to solicit quotes for final landfill cover and seeding. It is similar to the format used to complete the initial cover. We would appreciate any feedback you might have. It would be helpful to get it by February 1st since the Council would like to solicit quotes then.

Erl Tufte

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure] Landfarm
Finan Assur Liner
GW Corr Meas Methane
GW Monitoring O & M
GW Reports Run - On
Inspections
Other:

QUOTE FOR FILL MATERIAL HAULING
CITY OF BIG TIMBER
FEBRUARY 1999

The City of Big Timber is requesting quotes to load, haul and deposit final cover material from existing areas at the closed City Landfill site. Quotes shall also include seeding of the designated site. General requirements for the quote are:

- approximately 2,000 cy is required to be hauled and placed
- material is available at a maximum of 1500 ft from the site
- current location for inspection of material and volume is the old landfill site (Howie Road)
- quote must include *all work required* to load, transport and deposit *all of the necessary material and complete seeding* at a designated area on the landfill site
- bidders to furnish own equipment, labor, fuel, fertilizer, seed, etc.
- complete hauling by May 1 and seeding by May 15, 1999 (weather permitting)
- lump sum quote for the entire effort
- coordinate all activity with Ron Thomas, Public Works Director (PWD)
- placement of cover material and seeding must follow guidelines in the *Closure Plan, City of Big Timber (pp. 5-6 and Appendix D)*, which is available for review in the City Offices.
- insurances, licensing, bonding, etc., must meet State and City requirements

- quotes to be received until 5:00 pm, February 16, 1999. Submit to Ron Thomas, PWD
- a decision to be made no later than March 1, 1999

LUMP SUM QUOTE: $____________________

SUBMITTED BY: ____________________ (individual, contractor)

____________________ (contractor's license number)

____________________ (address)

____

____________________ (telephone)

file copy
mailed 7/9/98 ND

DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMITTING & COMPLIANCE DIVISION
Community Services Bureau
Waste Management Section
MARC RACICOT, GOVERNOR

STATE OF MONTANA

Phone: (406)444-4400
Fax: (406)444-1374

Metcalf Building
1520 E Sixth Ave
PO Box 200901
Helena, MT 59620-0901

July 9, 1998

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:
4-5
Landfarm
Liner
Methane
O & M
Run - On

Gary Smart
Mayor
City of Big Timber
P.O. Box 416
Big Timber, MT 59011

RE: Landfill Closure Plan Approval.

Dear Mayor Smart:

The Department approves the evapotranspiration alternative cover for the final closure of the Big Timber Landfill. Construction may commence at any time. In agreement with the USDA letter from Mr. Roloff, planting should be completed next spring. His recommendations should be closely followed in order to successfully establish a strong stand of native grasses that will use the moisture in the cap. The cover thicknesses indicated on Sheet 2 of the plans are the minimums allowed. Additional thicknesses are also allowable without further Departmental review. Any additional material would only improve the performance of the cap and planting success.

If you have any further questions on this matter, please feel free to contact me. My direct phone line is 406-444-5294.

Sincerely,

Patrick Crowley

F. Patrick Crowley
Acting Section Supervisor

cc: Earl Tufte, Morrison-Maierle, 2020 Grand Avenue, Billings, MT 59011
Brian Grant, Maxim Technologies, P.O. Box 4699, Helena, MT 59604
File: Big Timber Closure
Path: CB5403\wp\landfill\closure\swtgrass\planok

CITY OF BIG TIMBER
P.O. BOX 416
BIG TIMBER, MT 59011-0416

PHONE: CLERK 932-5610
TREASURER 932-5611
FAX 932-5611

May 5, 1998

RECEIVED
MAY 07 1998
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

Pat Crowley
Department of Environmental Quality
Waste Management Section
Box 200901
Helena, MT 59620

Re: Big Timber Landfill Closure.

Dear Mr. Crowley,

This letter is intended to add emphasis to the letter sent by Maxim Technologies on April 28, 1998. We request that you keep the following in mind while reviewing the closure Plan.

1. The City of Big Timber and Morrison-Maierle have been an active part of formulating the Closure Plan.

2. We believe that Maxim's proposal is consistent with your earlier support for an adequate, but low cost closure.

3. We appreciate your assistance to this date. You are well aware of the financial situation that lead to privatization of our solid waste operation and landfill closure. We hope that you will continue to keep this in mind as you review the Closure Plan.

4. The overall garbage footprint is small and we have kept up the site. It seems like the risk of any future environmental damage is minimal.

5. Some citizens still believe that we should have stayed in the solid waste business. This will only quiet down after we have put the closure behind us.

6. The City has in good faith continued to invest in the solid waste program. We have constructed a Solid Waste Transfer Station, funded the Solid Waste Study and carry out a recycling program.

The bottom line is that we need to put this matter behind us and move on to other priorities for the City of Big Timber. Your consideration of this as you review the closure Plan is appreciated.

Sincerely,

Gary Smart

Gary Smart, Mayor
City of Big Timber

cc: Erl Tufte, Morrison-Maierle
Brian Grant, Maxim Technologies

County SWEET GRASS CO. #308
Facility & # BIG TIMBER CLASS II, PC
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run - On

4-5

CITY OF BIG TIMBER
P. O. Box 416
Big Timber, MT 59011-0416

BILLINGS, MT 591
PM
6 MAY
1998

DO SOMETHING
WILD:
COLLECT STAMPS

USA 32

PAT CROWLEY
DEQ - WASTE MANAGEMENT SECTION
P.O. BOX 200901
HELENA, MT 59620-0901

RECYCLED

file copy

DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMITTING & COMPLIANCE DIVISION
WASTE MANAGEMENT SECTION

MARC RACICOT, GOVERNOR
Metcalf Building

STATE OF MONTANA

Phone: (406)444-4400
Fax: (406)444-1374

PO Box 200901
Helena, MT 59620-0901

To Maxim

FAXED
5/6/98
FPC

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run - On

4-5'

September 5, 1997

Erl Tufte
Morrison Maierle
2020 Grand Avenue
Billings, MT 59102

Dear Erl:

Thank you for the map of the Big Timber landfill. I do not see what the costly big problem is here. I have some suggestions , and I want to emphasize they are only that, that might help cut the costs here.

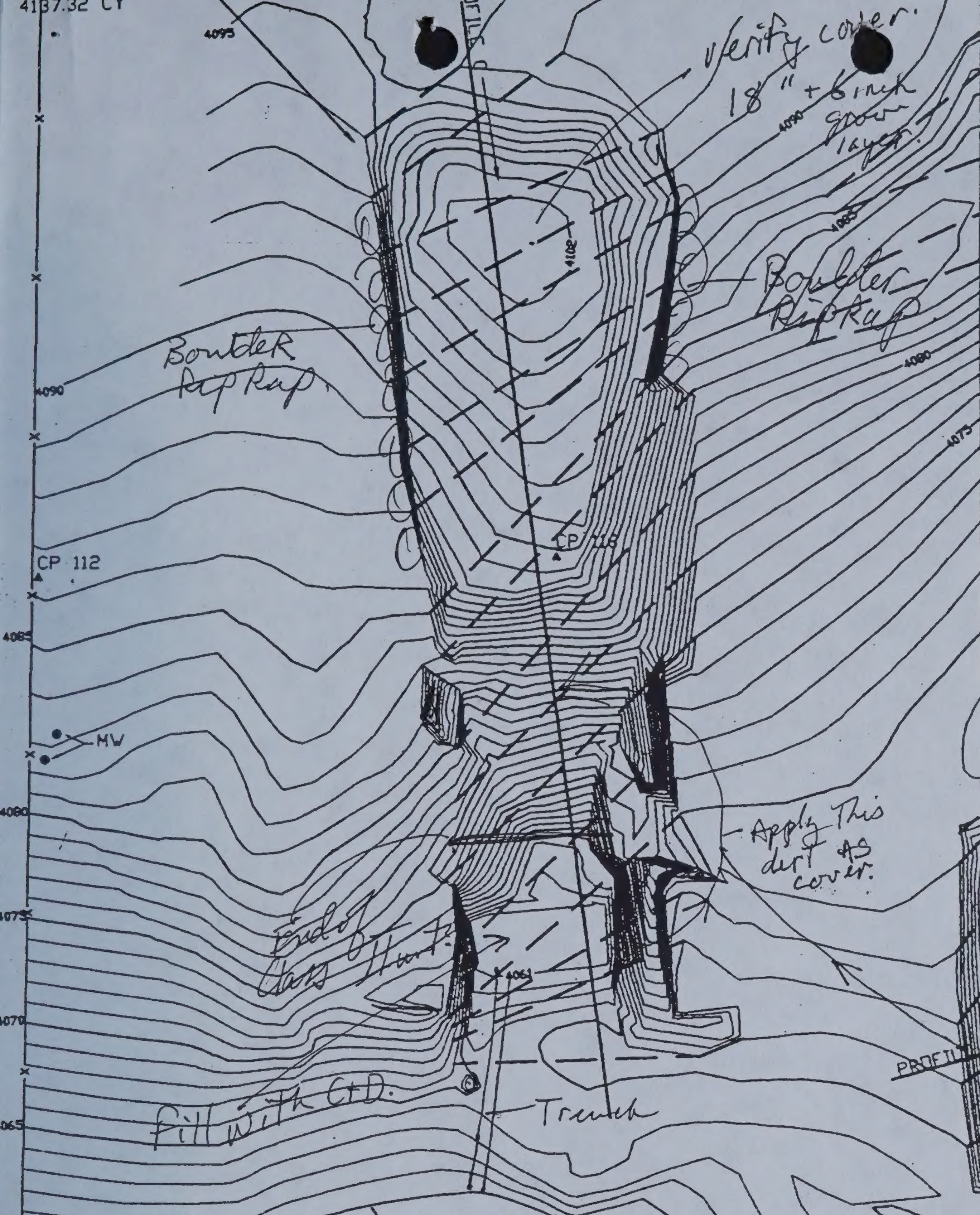
1) Use rest of trench as a Class IV unit for construction and demolition waste.
2) Verify cover thickness over Class II unit, add dirt as needed to total 18 inches. Use existing dirt from trench excavation and burn pit as cover. 6" growth layer from existing soil stockpile. Augment dirt with organic material from compost piles, manure, etc.
3) Backhoe a trench to daylight out the pond at the toe of the Class II unit. Put small catch basin at end of trench to control sedimentation.
4) Armor steeper sides of closed unit with oversize (+4") from a gravel pit. Do not worry about 3:1. Slopes are too short. (ARM 17.50.530(1)(b)(ii)-- Alternative final cover design.)
5) Leave burn pit as is.
6) Change license to Class IV.
7) Reduce ground water monitoring to annual. If OK for a few years, request end of monitoring.
8) Request extension to get the work done. (ARM 17.50.530(1)(g) allows this.)

I hope these ideas help. Give me a call if you want. 406-444-5294.

Pat

Pat Crowley

Map attached.


4137.32 CY
4095
verify cover.
18" + 6 inch grow layer.
4090
4085
4102
Boulder RipRap
Boulder RipRap.
4090
4080
4075
CP 112
CP 118
4085
MW
4080
Apply This dirt AS cover.
4075
End of Clay Hunt.
4061
4070
fill with C+D.
Trench
PROFIL
4065
4060
Sedimentation Basin
4055
4055

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Landfarm
Liner
Methane
O & M
Run - On
Other:

4-5

MORRISON MAIERLE, INC.
2020 Grand Avenue
BILLINGS, MONTANA 59102

(406) 656-6000

LETTER OF TRANSMITTAL

DATE 9·2·97 JOB NO. 2904.007-000.0200

ATTENTION

RE: Pat Crowley

Big Timber landfill
Closure

TO Mt Dept. of Environmental Quality
Solid Waste Program
Helena, MT 59620-0901

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via ______ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☒ Survey data

COPIES	DATE	NO.	DESCRIPTION
1	9·2·97		Copy of Survey done at the landfill

RECEIVED
SEP 03 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ______ copies for approval

☐ For your use ☐ Approved as noted ☐ Submit ______ copies for distribution

☒ As requested ☐ Returned for corrections ☐ Return ______ corrected prints

☐ For review and comment ☐ ______

☐ FOR BIDS DUE ______ 19 ______ ☐ PRINTS RETURNED AFTER LOAN TO US

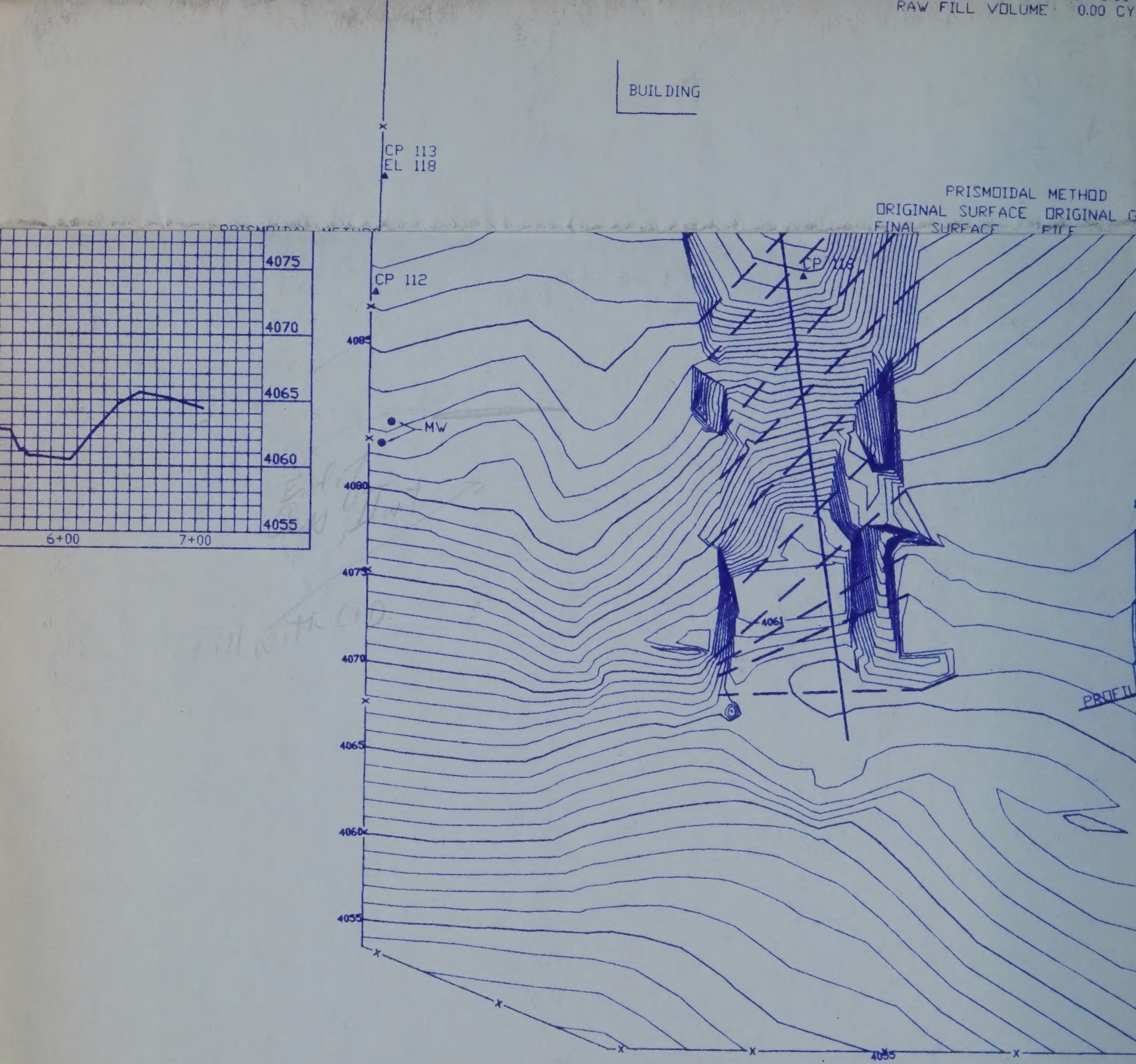
REMARKS Pat, as requested I am forwarding a copy of the recent survey done on the Big Timber landfill. I appreciate your proposal to mark it up with your ideas to get this done + at low cost.

I will await your response before any further discussions with the City, BFI, or Maxim regarding a realistic plan of action to get the closure completed.

COPY TO Lois Stevens - w/o enclosure.

SIGNED: Erl Tufte/kd

If enclosures are not as noted, kindly notify us at once.


RAW FILL VOLUME 0.00 CY
BUILDING
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EL 118
PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL
FINAL SURFACE PILE
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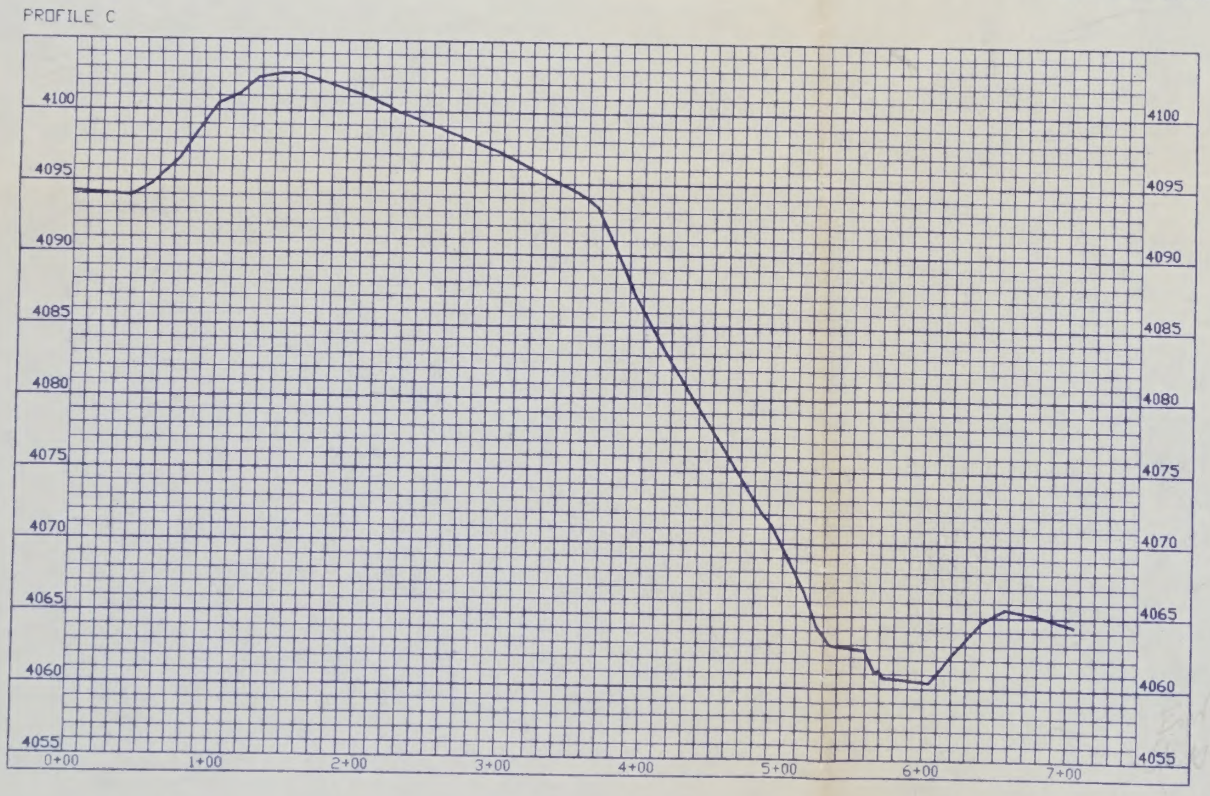
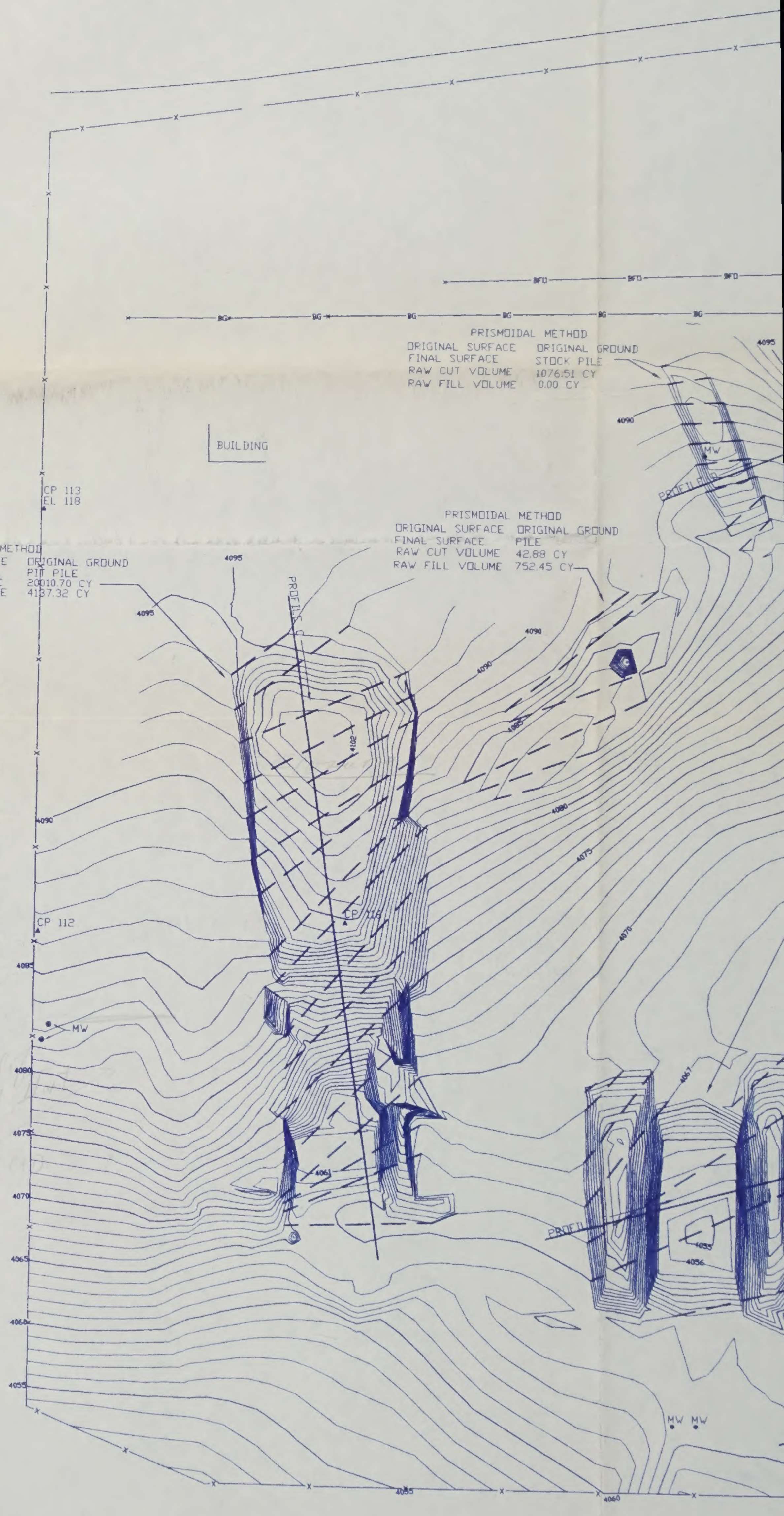
Fill with C.D.

RECEIVED
SEP 0 3 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

OFFICE COPY PLOTTED

CP 114




BUILDING
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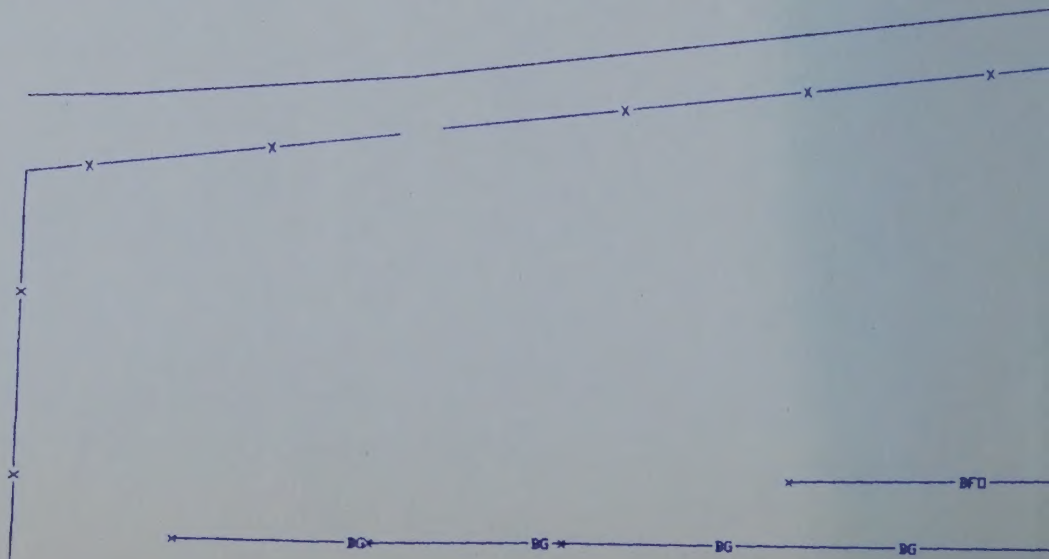
PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE STOCK PILE
RAW CUT VOLUME 1076.51 CY
RAW FILL VOLUME 0.00 CY

PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE PILE
RAW CUT VOLUME 42.88 CY
RAW FILL VOLUME 752.45 CY

PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE PIT PILE
RAW CUT VOLUME 20010.70 CY
RAW FILL VOLUME 4137.32 CY

H:\3044.001\030\DWG\3044001 Fri Jul 18 14:25:55 1997

OFFICE COPY PLOT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PRISMOIDAL METHO
ORIGINAL SURFACE ORIGINA

JUL-11-1997 10:58 FROM I, BLLLINGS, MT. TO 120044452758346 P.01

Big Timber Closure

FAX TRANSMISSION

Engineers
Scientists
Planners
Surveyors

MORRISON-MAIERLE, INC.
Since 1945

2020 Grand Avenue
Billings, MT 59102
Phone: (406) 656-6000

DATE: 7-11-97 **PROJECT NO.:** ____________

SEND TO: Pat Crowley

FAX NO.: 444-5275

FROM: Erl Tuffe

THIS IS PAGE 1 OF 3 **PAGES**

MESSAGE:

Called Erl about this. 7/22/97

RECEIVED
JUL 14 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

County Sweet Grass
Facility & # Big Timber 308

[✓ Closure]	Landfarm
Finan Assur	Liner
GW Corr Meas	Methane
GW Monitoring	O & M
GW Reports	Run - On
Inspections	

Other: ____________

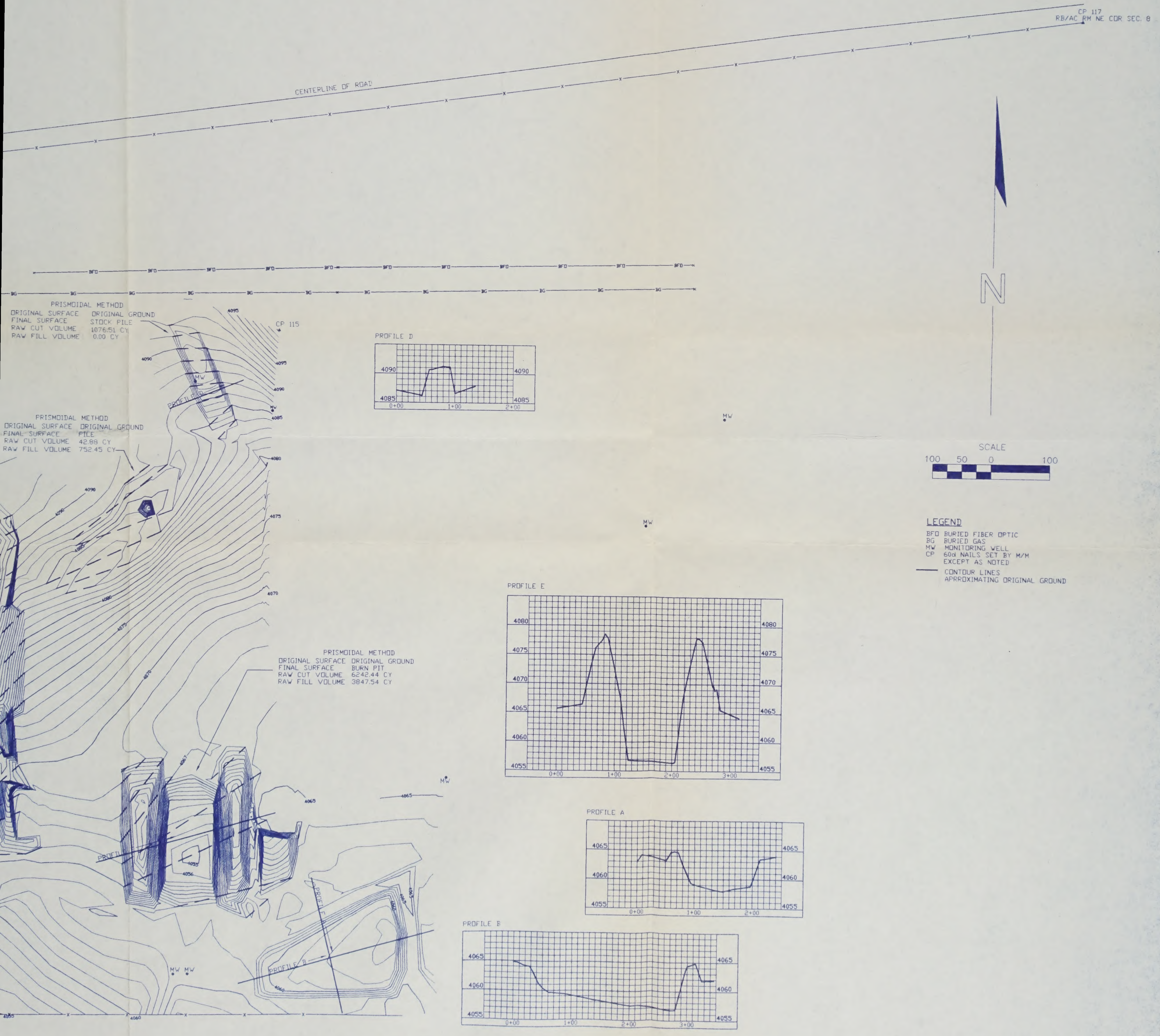
4-5

OUR FAX NUMBER IS (406) 656-3432

■ *AIRPORTS* ■ *HIGHWAYS* ■ *CONSTRUCTION ENGINEERING* ■ *PHOTOGRAMMETRY*
■ *STRUCTURES* ■ *SURVEYING* ■ *WATER* ■ *WASTEWATER* ■ *WATER RESOURCES*

W:\M0200\FORMS\FAX.FRM
April 21, 1997

PLOTTED [illegible] FILE BLOCK 1


CP 117
RB/AC RM NE COR SEC. 8
CENTERLINE OF ROAD
BFO
BG
PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE STOCK PILE
RAW CUT VOLUME 1076.51 CY
RAW FILL VOLUME 0.00 CY
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PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE PILE
RAW CUT VOLUME 42.88 CY
RAW FILL VOLUME 752.45 CY
PRISMOIDAL METHOD
ORIGINAL SURFACE ORIGINAL GROUND
FINAL SURFACE BURN PIT
RAW CUT VOLUME 6242.44 CY
RAW FILL VOLUME 3847.54 CY
PROFILE E
PROFILE A
PROFILE B
N
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100 50 0 100
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BFO BURIED FIBER OPTIC
BG BURIED GAS
MW MONITORING WELL
CP 60d NAILS SET BY M/M
EXCEPT AS NOTED
CONTOUR LINES
APRROXIMATING ORIGINAL GROUND

JUL-11-1997 10:58 FROM I, BLLLINGS, MT. TO 20044452758346 P.01

Big Timber Closure

FAX TRANSMISSION

Engineers
Scientists
Planners
Surveyors

MORRISON-MAIERLE, INC.
Since 1945

2020 Grand Avenue
Billings, MT 59102
Phone: (406) 656-6000

DATE: 7-11-97 **PROJECT NO.:**

SEND TO: Pat Crowley

FAX NO.: 444-5275

FROM: Erl Tuffe

THIS IS PAGE 1 OF 3 **PAGES**

RECEIVED
JUL 14 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

MESSAGE:

Called Erl about this 7/22/97

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run - On

4-5

OUR FAX NUMBER IS (406) 656-3432

■ *AIRPORTS* ■ *HIGHWAYS* ■ *CONSTRUCTION ENGINEERING* ■ *PHOTOGRAMMETRY*
■ *STRUCTURES* ■ *SURVEYING* ■ *WATER* ■ *WASTEWATER* ■ *WATER RESOURCES*

W:\M0200\FORMS\FAX.FRM
April 21, 1997

BFI

PLEASE FAX A COPY
TO PAT CROWLEY, DEQ
(444-5275).

July 2, 1997

City of Big Timber
103 East 3rd Street
P.O. Box 416
Big Timber, Montana 59011

Dear Council Members:

The following is a summary to date on the status of the landfill closure.

In late June, Jim Stout, closed site director for BFI toured the landfill in Big Timber to assess primarily the size of the cell and the available dirt and fill on site to perform a landfill closure that complies with the parameters of Sub Title "D" regulations. Ron from the City and a local dirt contractor were also present at the site visit. Issue of concern are as follows:

1) There is a shortage of top soil stockpiled at the site. Based on discussions with Ron when the site was constructed the top soil was stockpiled for future use. By our estimates we will need to either mine top soil adjacent to the cell, export top soil from some where else, or manufacture soil with other low base material.

2) At the north end of the trench there is a low spot that will require some sort of fill to complete the contour of the cell. Both the east and west side of the trench will need some fill to decrease the angle of the slope. The current angle is so steep it will just erode and probably will not sustain growth of a vegetative cover.

3) The burn pit needs to be addressed on how its use will be developed in the future.

4) The scrap tires will need to be removed from the site prior to closure

5) We met with Pat Crowley from the State DEQ program to discuss some basic parameters of which we will need to comply with. A 18 inch frost layer will need to be placed below a 6 inch growth layer that meets 10 to the minus 5th.

6) We discussed with Pat using some class III wastes as fill at the north end of the trench to fill the low spot. Pat requested we provide a profile of what class III wastes we had in mind. Ron said the City has some material, about 1500 yards. We are now looking for other potential class III waste that we would charge a tipping fee for to not only fill the hole but develop a revenue stream to the City to help pay for the landfill closure. We approached the Stillwater Mining Company which has a large stockpile of "Spent Gypsum" to see if they were open to disposing of the material at the site at a nominal tipping fee. They were very interested and have provided to use some testing science so that we may provide it to the State DEQ as a proposed class III waste.

Missoula District · 1501 Rodgers · P.O. Box 8449 · Missoula, Montana 59802
Phone 406-543-3157 · Fax 406-543-5196

30% Post-Consumer

7) Other sources may be the City WWTP residuals, and any other local construction and demolition wastes.

8) We will be required to involve a licensed PE to oversee the project. I have contacted Earl Tufty so see if their firm is interested.

9) Some engineering, surveying, and geoscience will need to be done for the landfill closure.

10) The dirt mover felt he would move dirt for about $3.00 per yard

We will continue to work on this project with hopes of submitting to the State a proposed plan as well as a profile on fill material in the next two weeks. I would add that the State was eager to be helpful in the closure process which was refreshing to see.

Should any of the council member have any questions or concerns please call me at (800)823-8231

Sincerely,

Cliff Boyd

Cliff Boyd
BFI of Montana Inc.

cc: Dennis Johnston
Jim Stout

Kent R. Douglass
William F. Frazier, Jr.
also admitted in Alabama
Brenda R. Gilbert
also admitted in Washington

John Frohnmayer
also admitted in Oregon
cooperating attorney

Swandal, Douglass, Frazier & Gilbert
ATTORNEYS
206 East Callender Street
Livingston, Montana 59047

Telephone
406-222-3301

Fax Number
406-222-3308

RECEIVED
JUN 05 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

June 4, 1997

Pat Crowley
Department of Environmental Quality
Solid Waste Program
P.O. Box 200901
Helena, MT 59620-0901

Re: Closed Big Timber Landfill

Dear Mr. Crowley:

I am writing on behalf of the Big Timber City Council to pass along information about the closure of the landfill in Big Timber. As you may recall, the landfill is actually closed and we quit taking waste material on April 9, 1997. Our proposed final closure date is January 1, 1999. We would appreciate your sending to us specific Solid Waste Bureau requirements, time tables and steps which we need to follow in order to comply with the variety of regulations in properly closing the landfill.

If it meets with the approval of your agency, we would like to consider using the landfill site to dispose of wastewater treatment plant sludge, rock and gravel from street restoration, utility trench excavation and rebar-free concrete.

In all likelihood, we will have BFI do a design-build approach where they provide the closure plan, survey, engineering and actual construction. It is our intention to retain ownership of the entire site for a period of time sufficient to ensure that any problems will be resolved.

At the time we closed the landfill on April 9th, 1997, we privatized the entire garbage business with BFI and it is our desire to complete the closure process as quickly and cost effectively as possible. I know that you have been to Big Timber several times to discuss this with the City officials and are certainly familiar with what we need to do.

Another concern we have is obtaining as much relief as possible from excessive sampling and testing requirements. To the extent we can do this, we would appreciate your assistance.

If you need any additional information from us at this time, please let us know. We will appreciate your cooperation in this matter and will look forward to working with you.

Yours truly,

Bill Frazier

WILLIAM F. FRAZIER, JR.
Big Timber City Attorney

WFF/sac
cc: City of Big Timber

IMPORTANT MESSAGE

FOR Pat Crowley

DATE 1/3 TIME 9:32 [✓ A.M.] P.M.

M Earl Tufte.

OF ~~M~~ Morrison-Maierle

PHONE 656-6000.
AREA CODE NUMBER EXTENSION

TELEPHONED	✓	PLEASE CALL	✓
CAME TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		RUSH	
RETURNED YOUR CALL		SPECIAL ATTENTION	

MESSAGE 6:00 pm Pre-Council Mtg. Big Timber Monday

Call ASAP – Super & – Big Timber.

932-8898

SIGNED Paula

LITHO IN U.S.A.

TOPS 3002-S

711 W. Russell Street
Sioux Falls, SD 57104
(605) 336-1960

B&S
Brown & Saenger

NOTES

Talk about closure
& closure costs —

Lowis Stephens —
932-5610

Ck

MORRISON
MAIERLE, INC.
An Employee-Owned Company

ENGINEERS
SCIENTISTS
SURVEYORS
PLANNERS

2020 GRAND AVENUE • BILLINGS, MT 59102 • 406-656-6000 • FAX: 406-656-3432

File: Big Timber
landfill #30-8
Sweetgrass Co
Closure file

FAX REQUEST / TRANSMISSION

DATE: 1/3/97

NO. OF PAGES (Including Cover) TRANSMITTED: 5

TO: Pat Crowley

COMPANY: DEQ solid Waste Bureau

FAX NUMBER: 444-1374 TIME: 1:25 a.m. [✓ p.m.]

PROJECT NAME: Big Timber

PROJECT NUMBER: 2904.003-010-0200

FROM: Erl Tufte

****

REMARKS / INSTRUCTIONS:

If any part of this transmission is poorly received, or is missing, please call MMI at (406)656-6000 or Fax (406)656-3432.

a:\kd\wp\junk.faxcover.frm
May 15, 1996

Bigt-ltr.13

FAX to Pat Crowley (444-1374). Pat, this will be part of discussion in Big Timber on Monday night. It is considered a draft with lots of room for changes and input including yours..

Erl Tufte

STAFF RECOMMENDATION
SOLID WASTE PROGRAM
JANUARY 1997

Introduction

The City of Big Timber requested proposals to provide municipal solid waste collection and disposal services because the City Council wished to discontinue its public operation. Requested proposals were for two options for disposal, the current landfill site or another site available to the private firm. In the first option the proposing company must take possession and ownership of the current site.

The City received two responses to its Request for Proposals (RFP). One proposal was from Browning Ferris Industries (BFI) and the other from Three Rivers Disposal/Ben Sale (TRD). Both proposed on the out-of-area landfill option, but only Three Rivers proposed on the existing landfill option (TRD-1).

Recommendation

Our recommendation is to negotiate a 10 year contract with BFI for solid waste disposal and collection services. Their proposal was the strongest, most complete and was rated the highest.

Current Practice

The City of Big Timber currently provides both solid waste collection and disposal. In 1991, a new landfill was opened. The City has experienced very high costs in this operation. In 1996, ATLATL, Inc., recommended that the landfill be closed, and the solid waste program be privatized. A public meeting was held on this issue on July 8, 1996. On November 4, 1996, the City Council authorized the request for proposals for privatized services.

RFP Response Comparison

The individual proposals outline each proposer's view of a private collection and disposal operation. The following is a brief staff comparison and comment on specific parameters that proposing firms were advised to address:

1. Collection. Both firms insured 1-3 pickups per week to serve residential, commercial and park customers. BFI's proposal more specifically identified the hours and days of operation.

2. Disposal. BFI identified a guaranteed 10 year contract at the Gallatin County Landfill. Three Rivers proposed either the existing site or Logan, Bozeman, Park County or East Helena Landfill.

3. Transfer Station. Although a transfer station was not required, BFI offered to lease the existing building as a transfer station.

4. Class 3 Disposal. Both firms identified roll off containers as the means of providing this service. BFI indicated that they were waiting on approval of a Livingston site for disposal.

5. Spring/Fall Cleanup. Three Rivers offered this at no charge. BFI limited their no charge option to 3 cans per household.

6. Administrative. Both firms agreed to pay the City $1.25 and $2.50 per account per month to provide billing, collection and support services. Three Rivers, however, expressed a desire to do the commercial ($2.50) accounts themselves.

7. Curbside or Alley Pickup. Both firms committed to provide each type of collection.

8. Mandated Service. Both firms complimented the City for proposing this, and suggested that it helped to control their rates. BFI offered an audit of accounts.

9. Close Landfill. Under one option, Three Rivers would assume the land, solid waste and closure of the existing site. Both firms offered technical assistance regarding closure.

10. Employee Hiring Agreement. BFI committed to hiring the 2 current employees. Three Rivers only agreed to give them "priority to the extent possible."

11. Franchise Fee. Both firms recognized such a fee as a growing trend in communities, and agreed to pay it. Three Rivers offered an added incentive based on a per ton charge if the current landfill is assumed by them. This could increase the fee from $20,000 to $26,000.

12. Purchase Landfill Equipment. Both firms quoted figures on equipment value, approximately $100,000.

A few other significant items were proposed:

13. Drop Off Center. BFI propose lease of the existing landfill building for $9,900 to serve as a Drop Off Center. They identified specific modifications that would need to be made ($15,000).

14. Recycling Center. BFI proposed a recycling buy back center at the transfer site. They identified this as an opportunity to encourage recycling and offer cash for doing it.

15. Purchase Collection Equipment. BFI specifically offered $64,475. Three Rivers offered market value plus 5%, an unknown at this time.

16. Escalation Clause. BFI proposed the national Consumer Price Index (CPI). Three Rivers proposed 90% of the Western States CPI.

Proposal Evaluation

Based on the Evaluation Criteria listed in the RFP, we rate the proposals as follows:

	TRD-1	TRD-2	BFI
Cost and Payment (45%)	*40*	*32*	*36*
Background and Strength (15%)	*10*	*10*	*15*
Liability Provisions (10%)	*7*	*7*	*9*
Schedule Commitments (10%)	*7*	*7*	*8*
Regulatory Compliance Provisions (10%)	*8*	*8*	*9*
Technical Provisions (10%)	*6*	*6*	*8*
TOTAL	**78**	**70**	**85**

Other Considerations

Closure Costs. Both firms suggested $70,000-$80,000 for closure costs. The State of Montana Solid Waste Bureau (SWB) has suggested that $30,000 may be adequate.

Financial Assurance. Closure of the landfill by April 1997 avoids further requirements related to providing financial assurances.

Landfill Site Sale. Area ranchers have proposed to purchase the existing landfill site. They are interested in the development potential, and in avoiding a regional landfill. As mentioned earlier, the best proposal financially for the City is to turn the landfill over to Three Rivers. To provide a similar package, we recommend the following sale conditions to the ranchers:

Land purchase (80 acres, $2000/acre)		$160,000
Closure (by ranchers)	estimated value	30,000
Post closure insurance (by ranchers)		10,000
TOTAL		**$200,000**

The City would retain 10 acres, an access road, the existing building, the landfill footprint and access to monitoring wells. The City Attorney should prepare the necessary documents. The City has discussed the transfer station and recycling center at a different location.

Final Negotiations

We recommend that the final contract negotiations include the following on above items:

2. Evidence of Agreement
4. Evidence of Agreement
5. Negotiate larger, special items

10. Firm commitment
11. CPI escalation clause
12. $100,000 firm
13. $12,000 per year (City to pay for improvements)
15. $75,000 firm
16. Identify specific CPI

Proposed Contract

We recommend that BFI prepare and offer for review and edit a contract between the City of Big Timber and BFI. This contract must include pertinent sections of the RFP, RFP response and subsequent negotiations. It should be available for review by January 28, 1997 and for adoption by the City Council by February 12, 1997. The land sale agreement should be similar.

Impact on Rates

The current rates on a monthly basis are________________________________ The new rates by BFI would approximately $18 per month. While this does not represent a major reduction in rates, it does recognize a number of *avoided costs* that we would face if we continued with service. These include: (1) equipment replacement, (2) landfill closure, (3) landfill post closure, (4) potential new regulations, (5) financial assurances and (6) reduced liability.

Disposition of Fund Proceeds

Franchise Fee: 50% debt service. 50% street fund.

Administrative Charge: General Fund (for clerical services).

Debt Reduction:

Equipment	$175,000
Land Sale	$160,000
Lease	12,000/yr
Franchise Fee (50% for 3 yrs, then to composting)	10,000/yr
Current Fund Balances	???
TOTAL	$

Prepared by:
Erl Tufte
Ron Thomas
Lois Stevens

Big Timber
Closure

Blue Ridge Services • P.O. Box 4054 • Bozeman, MT 59772-4054

Telephone (406) 587-8771 • Fax (406) 587-8771

County Sweet Grass
Facility & # Big Timber 308
[✓ Closure]
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:
4-5
Landfarm
Liner
Methane
O & M
Run - On

December 13, 1996

Ray Schwaller, P.E.
MSE/HKM, Inc.
1 Last Chance Gulch
Helena, MT 59601

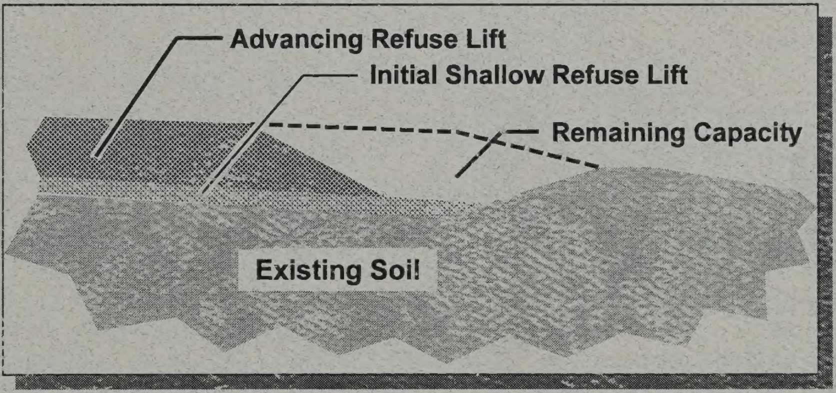
RE: BIG TIMBER LANDFILL CLOSURE

On 12/9/96, I visited the Big Timber Landfill and conducted a brief site evaluation. After the site visit, I stopped by the City Hall office and reviewed the site development plans which were prepared by Damschen & Associates. The following site description is based on what I learned during that site visit and through subsequent discussions with the DEQ.

SITE DESCRIPTION

Waste Cell The existing site was opened in 1991. All filling has occurred in a single trench that is approximately 600' by 100' (based on the plans). I would estimate that the actual field width is closer to 140'. Thus the area to be closed is estimated at approximately 2 acres.

Although the cell was constructed prior to the effective date of Subtitle D, the base of the cell was built of re-compacted soil.



The cell has been filled in 2 lifts (See Figure 1). The first life was quite thin and assume served to establish the active footprint. The second (and final) lift is somewhat thicker (i.e., approximately 15' deep). The final lift is progressing from north to south. At the time of my visit, the advancing toe of the final lift was still approximately 100 feet from the south end of the landfill. Thus, in order to fill bring the south end of the trench up to grade so that it will drain, it will be necessary to continue filling for a few months. As an alternative, a drainage swale could be cut into the existing soil on the south end of the trench.

Leachate Additionally, a simple gravel-filled leachate sump and riser was installed at the south end of the cell. According to the site operator (Steve), there has never been leachate in the sump.

However, he also stated that the first lift of garbage which was placed across the base of the cell was quite shallow (a few feet thick). Thus it is likely that the underlying waste could be saturated and may produce leachate at some time in the future. Also, it is possible that over time, the main by-products of decomposition (e.g., water, methane and CO_2 might create leachate and/or impact the groundwater monitoring wells. For this reason, I suggest that the post-closure costs (which are not addressed in this cost estimate) take into account the potential cost of handling leachate at some point in the future.

Burn Pit There is a burn pit located southeast of the main pit. At the time of my visit, the burn pit was virtually empty. I assume that they had recently burned whatever brush and wood had accumulated. There was a small pile of tires in the southwest corner of the burn pit. These could easily be placed in the main waste cell or, if the site were re-designated as a class 3 landfill, the tires could go into a class 3 area.

Petroleum-Contaminated Soil The site has received a limited amount of petroleum-contaminated soil (PCS). The few cubic yards of PCS have historically been landfarmed in a small area on the southeast end of the site, near a natural drainage coulee. This area is approximately 30' by 30'. Based on discussions with the site operator (Steve), after a short period of landfarming, the PCS is relocated and placed into the active landfill cell. At the time of my visit, the PCS area showed evidence of recent tilling. There was an obvious odor of petroleum. I anticipate no problems in moving the remaining PCS into the landfill prior to closure. I suggest that we obtain a formal "OK" from the DEQ if landfarming of PCS is to continue after closure of the landfill. (Note: discussions with Pat Crowley - DEQ indicate that continued PCS landfarming would be allowed). However, I would recommend that the landfarming area be relocated to an area further away from the coulee and that a drainage basin be constructed to contain any runoff from the PCS area.

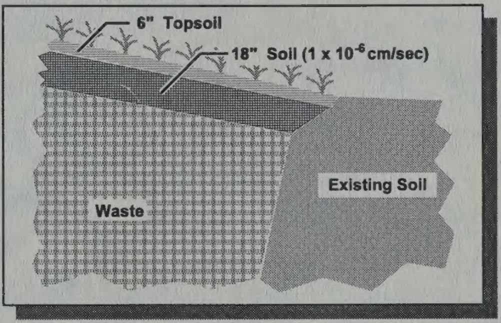
RECOMMENDED CLOSURE METHOD

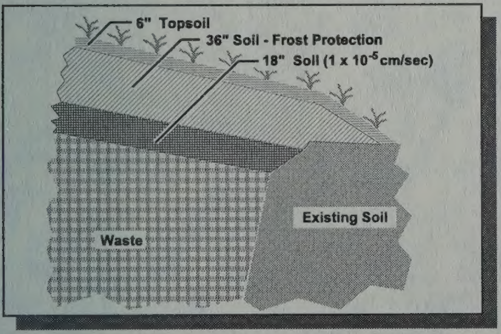
Based on discussions with Pat Crowley (DEQ), it is my understanding that due to the minimal amount of effort put into creating a liner, the state would likely consider the site to be "unlined." Thus, the cap could be constructed in much the same manner as the liner (i.e., recompacted on-site soil). In this case, 18" of 10^{-5} cm/sec would meet the state's closure requirements.

There is a concern that in order to provide frost protection, the site may have to be capped with an additional layer of random soil. Depending on the typical frost depth at Big Timber, the required depth could range from 2'-5'. As an alternative, Pat Crowley suggested that if we were able to obtain an 18" layer of soil with a permeability of 1 x 10^{-6} or less, then the requirement for additional soil for frost protection might be waived.

ESTIMATED CLOSURE COSTS

The following costs are intended to be estimates only. In order to identify more accurate costs, it will be necessary to conduct some basic soils testing. For example, will our cap consist of 18" of soil with a permeability of 1 x 10^{-5} plus additional soil for frost protection or, can we just cap the site with 18" of soil with a permeability of 1 x 10^{-6}. As you can see from the following cost scenarios, this makes a considerable difference as to the cost of closure.





Option No. 1 describes the simplest system for closure (See Figure 2). If the soils are able to meet a permeability specification of 1 x 10^{-6} cm/sec, then this option will likely be accepted by the state DEQ. The cost to close the landfill under the Option 1 scenario is estimated at $60,800.

Option No. 2 describes the more elaborate system for closure (See Figure 3). If the soils are only able to meet a permeability specification of 1 x 10^{-5} cm/sec, then it is likely that the state DEQ will require us to place additional soil (for frost protection) on top of the cap. The cost to close the landfill under the Option 2 scenario is estimated at $85,800.

Please review this and contact me at your convenience.

Respectfully,

Neal Bolton

CITY OF BIG TIMBER

SOLID WASTE MANAGEMENT
DRAFT
ALTERNATIVES ANALYSIS REPORT

March 27, 1996

prepared by:

ATLATL, INC.
Butte, Montana

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TABLE 4
BIG TIMBER LANDFILL
NEW LANDFILL CELL CLOSURE COST ESTIMATE

Item	Cost/Unit	Units	Quantity	Cost
Contour site and apply intermediate cover	Included in operating costs			
6" bedding layer (3/4" minus)	12.00	cu.yd.	4,400	52,800
Geosynthetic clay liner	0.65	sq.ft.	253,125	164,531
60 mil HDPE liner	0.45	sq.ft.	253,125	113,906
Geotextile cushion fabric	1.80	sq.yd.	28,125	50,625
12" gravel drainage layer	12.00	cu.yd.	9,375	112,500
18" protective cover layer	1.50	cu.yd.	14,050	21,075
6" topsoil layer	2.00	cu.yd.	4,700	9,400
Seeding and mulching	600.00	acre	6	3,600
Construction QA and QC	25,000.00	lump sum	1	25,000
Subtotal				$553,437
Contingency (15%)				$83,016
Total closure cost estimate				$636,453
Closure trust fund payment(1)				$31,823

(1) 1/20th of total cost based on a landfill unit (cell) life of 20 years for a 20 year pay in period as per ARM 16.40.540(5)(ii & iii).

TABLE 5
BIG TIMBER LANDFILL
POST-CLOSURE COST ESTIMATE
ANNUAL COSTS FOR 30 YEARS AFTER CLOSURE

Item	Annual Cost
Groundwater monitoring	10,000
Methane monitoring	1,000
Annual inspections and reporting	1,000
Cap maintenance	1,000
Subtotal	$13,000
Contingency (15%)	$1,950
Total annual post-closure cost estimate	$14,950
Total cost for 30 years	$448,500
Post-Closure trust fund payment(1)	$4,983

(1) 1/90th of the total cost based on a 60 year landfill life plus 30 years post-closure for a 90 year pay-in period as per ARM 16.40.540(5)(ii & iii).

Closure

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Waste Management Division
Solid Waste Program
406/444-1430

FAX # (406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

September 2, 1994

Kevin J. Hutchins
City of Big Timber Landfill
PO BOX 416
Big Timber, MT 59011

Dear Mr. Hutchins:

I have reviewed the additions to the Big Timber Landfill's Plan of Operations as proposed in your letter of June 2, 1994 and have the following comments:

Waste Screening Plan

The Plan as proposed meets the regulatory requirements for the waste stream anticipated at the landfill. Please remember that all of the waste screening records should be made a part of your operating record and be available for review during Department inspections.

Methane Monitoring

The regulatory requirements for methane monitoring are 25% of the LEL in facility structures and 100% of the LEL at the property boundary. Since the requirements also include that the monitoring be based on site soils, hydrogeology, potential pathways, potential barriers, water levels, and the structures and property boundaries (i.e. distance to the boundary and then the distance to other persons). The methane monitoring plan should include:

1. A map depicting the proposed locations for methane monitoring should be supplied to the Department for approval. This map should show the location of any nearby structures as well as facilities at the landfill.

2. Depth of the proposed probe locations. The methane monitoring points must be located based on the depth to the water table and the depth of any nearby refuse as well as the pathways (like sand lenses) and barriers (such as frost in the winter). The geology at the Big Timber site is such that the water beneath the landfill is mostly in what is called a confined aquifer. This indicates that most of the methane migration pathways should be above this level. Special attention should be paid to shallow sand lenses that are intercepted by the trenches at the landfill.

3. Suggested locations include on the fence line due West of the current trench, by the gate, and on the fence line due south of the trenches.

4. Culverts should be sampled. Methane/CO_2 mixtures are heavier than air and tend to accumulate in low lying areas.

5. The make and model of the methane meter selected should be supplied to the Department. It should be calibrated with an appropriate methane gas mixture and operated according to the manufacturer's instructions.

I am enclosing a copy of a simple methane plan from Valley County for your information.

Leachate Collection System

The leachate collection system must be operated so that no more than 1 foot accumulates prior to removal. The use of the same probe to measure water levels in the leachate system and the ground water monitoring wells is strongly discouraged. One accidental cross contamination will more than nullify any cost savings of not using dedicated equipment. A simpler method, such as the use of a series of 1 inch PVC pipe sections to probe the leachate riser might be just as effective and cheaper.

The design of the current cell's leachate collection system does not meet the new requirements of Department regulations adopted as a result of the EPA's Subtitle D rules. The next cell (trench) will require a liner and leachate collection system that meets the requirements of ARM 16.14.506. Unfortunately, the Department is not in the landfill design business and will only be able to review designs presented to insure that they meet the regulatory requirements. I would urge you, if you will be continuing to use the landfill beyond the life of the current cell, to begin the design process at least a year in advance of the need for additional space. The design, bidding, and construction may take longer than anticipated. Design requirements are specified in ARM 16.14.506.

Ground Water Monitoring

There appears to be some confusion regarding the status of ground water monitoring at the Big Timber Landfill. As Patricia Potts stated in her letter of April 19, 1994, the seven wells present at the site are adequate to provide for the initial hydrogeological characterization of the site but are not necessarily adequate as a monitoring network. In that letter she also said that Big Timber should immediately begin monthly water level measurements so that an assessment of the flow direction could be made in August and a determination of the adequacy of the existing well placement could be

made prior to October 9, 1994. Since these measurements were not performed, the Department does not have the additional information required to make a decision on these matters. Please commence the required monthly water level measurements at once.

One of the primary reasons for sampling all seven wells was the ability to create a sufficient population of samples for the required statistical evaluation of sampling results. The lack of water level measurements may require that the Department, instead of being able to evaluate a proposed monitoring network, may have to require that a second round of sampling be conducted on all seven wells again in the spring, rather than concentrating the sampling on a reduced number of properly located wells. Please consult with Huntingdon Chen-Northern on the groundwater data analysis required by ARM 16.14.706(12).

A sampling and analysis plan for the landfill is also required. For the first event, the Standard Operating Procedures used by Huntingdon will suffice as this firm has been active at several landfills in Montana and is familiar with Department regulations. They can advise you on the requirements of ARM 16.14.706(1).

Closure Plan

For the time being, the Department has accepted the closure plan as presented on Plan Sheet 4 of 9. "Final Contour Plan" of the Damschen and Associates plans for the landfill dated February 1990. This design may have to change as the Big Timber Landfill progresses to lined cells. The permeability of the final cover infiltration layer must contain a minimum 18 inches of earthen material and have a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. I would also call your attention to the construction QA/QC requirements of final cap design specified in ARM 16.14.506(12). The requirements normally require the services of a professional engineer.

The closure of landfill units must be completed within 180 days of the start of closure activities. The unit must be revegitated within one year. The vegetation of closed areas should be done with a grass mix approved by the Soil Conservation Service for the area.

A notation must be placed on the deed to the property indicating that it was used as a landfill.

An estimate of the cost of a third party to close the largest area of the landfill requiring final closure (and proof of the financial mechanism to provide for the closure) must be provided to the Department by April 9, 1994. This estimate must be annually updated and appropriately funded. Must Montana towns do not have the

financial depth to provide the required financial assurance without setting up a dedicated trust fund. Financial assurance requirements are delineated in ARM 16.14.540.

A 30 year post closure care period is also required. These requirements are specified in ARM 16.14.531(1) and include:

> (a) Following closure of each Class II landfill unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for 30 years, except as provided under (b) of this subsection, and consist of at least the following:
> (i) Maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;
> (ii) Maintaining and operating the leachate collection system in accordance with the requirements in ARM 16.14.506. The department may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment;
> (iii) Monitoring the ground water in accordance with the requirements of ARM Title 16, chapter 14, subchapter 7, and maintaining the ground water monitoring system, if applicable; and
> (iv) Maintaining and operating the gas monitoring system in accordance with the requirements of ARM 16.14.521.

Following the thirty year post closure care of the unit, a certification by a P.E. must be submitted to the Department.

Run-off control and the Montana Pollution Discharge Elimination System (MPDES) Permit

Barry Damschen sized the run-off detention pond to handle the 24 hour, 25 year precipitation event. This meets current requirements. Your Operations Plan should also reflect a commitment to use appropriate Best Management Practices (BMP's) to eliminate possible point and non-point sources at the landfill. I have attached a copy of the EPA suggestions on BMP's at landfills for your reference.

Because the Big Timber Landfill pond design includes two potential discharge points, the spillway and the pipe, it will also require a Stormwater Discharge Permit from the Water Quality Division. Please contact Roxanne Lincoln at 444-5338 for the appropriate application form.

I hope this review of your submittal has been helpful. We understand that landfill operations under the new rules required by the EPA is

much more complex than before. If we can be of further help, please feel free to contact any of us at the Solid Waste Program.

Sincerely,

F Patrick Crowley

F. Patrick Crowley
Solid Waste Regulatory Lead

Enclosures: Valley County Methane, EPA BMP's

Big Timber ~~[illegible]~~ Co.
File:~~Twin Bridges~~ Landfill\~~Sweet Grass County~~
Path:H:\cb5403\wp\landfill\BIGT.OPS

June 2, 1994

Department of Health and
Environmental Sciences,
Solid and Hazardous Waste Bureau
Helena, MT 59620

Re: Operation plan additions.

Dear Sirs,

Enclosed you will find the information you requested. The City understands that this is the first draft of the proposed operational plan changes. Any changes or ideas from your department will be appreciated.

I would like to thank Lora Dando for her time and understanding, Jim Wilbur for his willingness to face the mis-informed citizens of Big Timber, and Pat Crowley for his simplistic explanation of the rules and regulations.

I am sure I will hear from you soon.

Sincerely,

Kevin J. Hutchins

Kevin J. Hutchins

RECEIVED
JUN 03 1994
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES

WASTE SCREENING

Big Timber has in place a waste screening program during the regular day to day operations of the Solid Waste Department. The Solid Waste personnel come into actual physical contact with all residential waste generated within the city limits. The Solid Waste personnel will accept liquid wastes from residential customers, with certain restrictions. These restrictions include:

1. Paint
    a. two gallons maximum per stop
        1. the city would prefer the lids on the cans be removed for 3-4 days to allow the VOC's to escape.

2. Used crankcase oil
    a. one gallon maximum in clear milk jug.

3. No 5 gallon container of any liquid will be accepted.

COMMERCIAL CUSTOMERS

Most commercial customers are picked up on a by the can basis therefore the city personnel can monitor the waste as it is being dumped into the truck. Any questionable waste is removed and the business owner is notified.

Presently, Big Timber is home to one of Montana's finest firearms manufacturers, Shiloh Rifle Company. The rifle company uses water soluble lubricating oil on their machines, and also uses a spinner to reclaim cutting oil from their metal filings.

Big Timber's garages and service stations either use their crankcase oil as fuel for heaters or contract to have the oil removed. All oil filters are punctured and drained before entering the waste stream.

AT THE LANDFILL

Customers at the landfill generally bring refuse to the landfill in the back of a pick-up. The city personnel inspect each load before it is dumped at the working face.

The Big Timber landfill has very few loads that are larger than pick-up size. These loads are generally dump truck and stock truck size. The larger loads are inspected after being dumped at the working face.

City personnel continue to inspect all refuse at the working face during the compaction and burying procedure.

The city will construct a simple waste screening pad following the guidelines on page 37 figure 7 of the Waste Screening at Municipal Solid Waste Management Facilities guidebook. This pad will be used for all questionable loads that enter the landfill.

If the city personnel find any waste that is unacceptable, we will contact the department of Health and Environmental Sciences, Solid and Hazardous Waste Bureau, and we will also contact Chen-Northern, Inc.

METHANE MONITORING

Landfill gas (LFG), produced during biodegradation of the waste can migrate through soils. Methane and Carbon Dioxide are the primary constituents. Methane is explosive and can collect in buildings or other confined spaces. Methane is explosive at concentrated levels between five percent (LEL) and fifteen percent (UEL) in air.

Methane is lighter than air and tends to rise through refuse or soil and vent into the atmosphere. A portable methane gas meter will be used to measure the concentration 4 times per year in facility structures, in leahcate riser, and at the facility property boundaries.

The Big Timber landfill operators will ensure that the concentration of methane gas generated by the facility does not exceed 25% of the lower explosive limit for methane at those areas that are monitored.

Need map of l.f. showing proposed locations.

1) What meter will be used. (Methane calibrate)

2) Quarterly monitor.

3) 100% LEL required —

Send.

LEACHATE COLLECTION SYSTEM

Purpose

The leachate collection system is designed to collect and convey leachate from the bottom of each pit. A series of perforated pipes are used for this purpose.

In order to detect and collect any leachate that may be generated in the most effective and economical method possible, the operation plan has been developed such that the base elevation of the various trenches slope in a down gradient direction toward the south side of the landfill.

Installation

Filter fabric was placed in the 3:1 slope trench for the leachate pipe.

A layer of coarse aggregate was placed over the fabric, then the pipe was put in. Another layer of coarse aggregate was placed over the pipe, and geo textile fabric was put down to help stop migration of waste and clay particles through the coarse aggregate that may clog the collection pipes.

Cleanout Risers

Cleanout risers are located on the west side of the trench and out of the fill area. The riser is protected by a six foot piece of steel pipe to help guard against accidental damage by landfill equipment.

Monitoring

The city personnel will check monthly for any leachate in the collection system. If leachate is found in sufficient quantities to cause alarm the city will contact the Department of Health and Environmental Sciences, Solid and Hazardous Waste Bureau and Chen Northern Inc.

The leachate riser is equipped with a steel cap that is padlocked at all times. After testing for leachate in the collection system, the probe must be cleaned to prevent the contamination of any groundwater monitoring wells. The probe will be used to measure the groundwater monitoring wells, also. The cleaning or decontaminating will be done per manufacturer's instructions.

GROUNDWATER MONITORING

The Big Timber landfill currently has 7 monitoring wells. The city will have all 7 of those wells tested for the required list of parameters/constituents listed in Table 1 of ARM 16.14.706. Upon the department's recommendation, the lab will also check for dichlorodifluoromethane in the down-gradient wells.

The city will also initiate a program for measuring water levels in all of the existing wells on a regular monthly basis. This program would coincide with the leachate collection system check.

The city understands this information will be instrumental in determining which wells will be included in the approved monitoring network, and if any additional wells will be needed.

With this information the city will establish a regular schedule for the required semi-annual ground water sampling. This sampling will coincide as closely as possible with high and low water periods during the year.

The firm of Chen-Northern, Inc. did the initial testing of all the wells and in all probability will do any subsequent testing. The city will advise Chen-Northern that the Department requires a Statement of Qualifications before any testing is done.

CLOSURE PLAN

Closure of filled trenches will be the responsibility of the City of Big Timber. Closure activities described below will take place sequentially as areas of the site are brought to final grades.

Closure of Filled Areas

The Big Timber operation plan is to close off a portion of the cell as the filling operation progresses. Final Closure will begin within 30 days after receiving the last shipment of waste. Final closure will be proceeded by contacting the Montana Department of Health and Environmental Sciences, Solid and Hazardous Waste Division before closure activities begin.

Closure will consist of placing a buffer soil layer, installing a clay barrier layer, placing eighteen inches of cover soil and six inches of topsoil and seeding with native grasses.

Access to the site following final closure will be controlled by providing a locked gate. The fence surrounding the property will be maintained.

The City personnel will make a monthly check for any erosion problems and take corrective action if needed.